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A Text-Book of Ophthalmic Operations

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of
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Chicago
W. T. Keener & Co.
90 Wabash Ave.
1907

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CHAPTER I

OPERATIONS ON MUSCLES

OPERATIONS on the extrinsic muscles of the eye are undertaken for one of four conditions, which are, in order of frequency, as follows:—

(1) As cosmetic operations, to remove some obvious deformity such as squint, with defective vision of the squinting eye.

(2) As a remedial operation, to give equilibrium of the ocular muscles in cases of squint with good vision of both eyes, and in cases of heterophoria.

(3) As compensatory measures, to make up for some loss of power of one muscle, by altering the position of attachment of one or more of its fellows.

(4) To remove enophthalmos.

Before embarking on the subject of the various procedures, it will be necessary to give a short account of the muscles and fasciæ of this region, both with regard to their anatomy and physiology.

The four recti muscles, with which the surgeon chiefly has to deal, arise from an oval fibrous ring, which is attached to the inner edge of the optic foramen, and thence bridges across the sphenoidal fissure to be inserted into a more or less prominent

spine on the posterior border of the great wing of the sphenoid. This fibrous ring is specially thickened above and below; these parts have received special names, and are known respectively as the ligaments of Lockwood and Zinn.

Thus, at their origin, the four muscles enclose the optic nerve within the circle of their tendons, and, diverging from one another, pass forwards, surrounding the nerve, until they reach the globe.

Here, at the level of the equator, their sheaths become continuous with the capsule of Tenon. During this, the orbital part of their course, their relations are, for the most part, simple. The parietal surface of each muscle—*i.e.* that turned towards the wall of the orbit—is covered by a thin layer of fat; in addition, the superior rectus has, overlying it, the levator palpebræ, to which it is attached by a fairly strong band: these two muscles are segments of a common sheet. The external rectus has important relations to the various nerves as they pass between its two heads into the orbit, but these are rather of anatomical than of surgical importance. It must be remembered, however, that the ciliary ganglion lies embedded in the orbital fat, between the muscle and the optic nerve, at a point about an inch from the apex of the orbit; this structure has been attacked in this position for the relief of glaucoma.

While they are in relation to the globe, the superior and inferior recti lie above the superior and inferior obliqui; the superior oblique, therefore, passes between the superior rectus and the eye.

In front of the equator the muscles converge again, and, becoming tendinous, pass forwards under Tenon's capsule to be inserted into the sclerotic at varying distances from the sclero-corneal junction. It is usually said that the tendons, by their insertions, form a spiral on the globe, the rectus internus being closest to the cornea, at a distance of about 5 mm., and the superior furthest, at a distance of about 8 mm., the inferior and externus being at 6 and 7 mm. respectively. Motais has pointed

out that this is really only very roughly accurate, since the tendon of no one of the muscles has its insertion concentric with the cornea, and the superior and inferior tendons are placed very obliquely. He has also drawn attention to the fact that the insertions are not placed symmetrically with the principal axes of the cornea: the superior rectus is implanted considerably outside the position required by symmetry, and the other muscles, although to a less degree, are also asymmetrical.

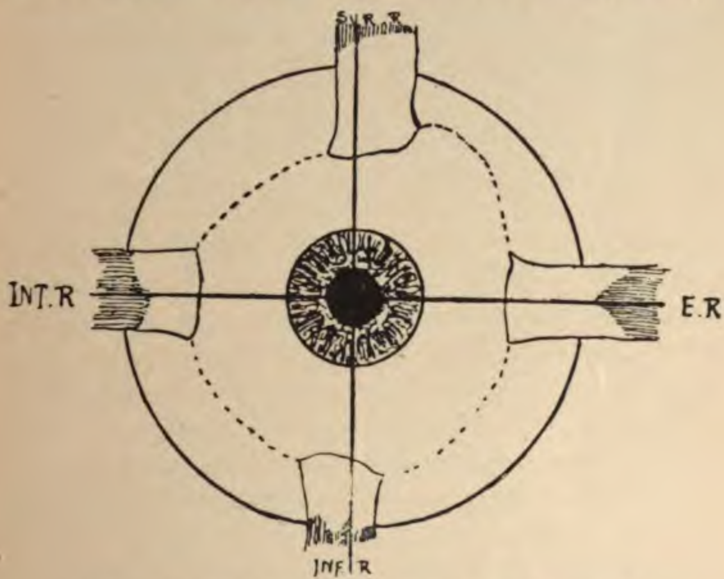

FIG. 1.—Relations of muscular insertions and Tenon's capsule. (By permission of Dr Motais.)

Their positions are given on the accompanying diagram, which is copied from Motais. The exact positions must be borne carefully in mind during the various operations on the muscles.

The fasciæ of the anterior part of the orbit are of great surgical importance; the best description of their arrangement is that found in the work of Motais (1), to which we have already alluded. It may be summarised as follows: the fascial muscular sheaths and the connective tissue between them, on reaching the equator of the globe, spread out forwards and

backwards over its surface, to form the capsule of Tenon. This fibrous sheet forms the anterior boundary to the inter-muscular cone of fat. In front of the equator the capsule passes forwards, under the conjunctiva and over the tendons of the recti, to blend near the margin of the cornea with the episcleral and subconjunctival tissues; into this blended mass the tendons of the recti send prolongations.

Just behind the equator a fascial sheet splits off the external muscular sheaths, to form the "funnel" (entonnoir), which, being attached all round the bony ring of the orbital margin, closes in this cavity anteriorly; certain parts of this are specially thick, and are known as the elastic ligaments of the muscles.

The lateral bands are the strongest and best marked—the inner attached to the caruncle and superior maxilla and the outer to the malar bone.

The older writers on ophthalmology, describing the physiology of the ocular movements, compared the globe in its capsule to a ball-and-socket joint; modern authors, and specially among them Motais, have pointed out that the comparison is misleading, because the capsule of Tenon, and the subjacent fat, share to some extent in the movements of the globe. By direct observation Motais has proved that when, for example, the internal rectus by its contraction rotates the posterior pole of the eye outwards, the capsule of Tenon and the fat move outwards also, though to a less degree than the globe itself. Further, he has pointed out that if the capsule were fixed and really formed a socket, the optic nerve would, of necessity, move up and down in its sheath like a piston in a cylinder. Such movement would be likely to interfere with the delicate nervous mechanism, and certainly does not take place.

In many animals—*e.g.* ruminants, who have free movement of their eyes—the space of Tenon is hardly at all developed. A large muscular mass, the choanal muscle, is inserted into the posterior part of the sclerotic directly: here there is no space of Tenon, yet movements are unimpeded. The choanal muscle and the adjacent fat must, in these circumstances, move with the globe.

It is clear, then, that the comparison to a diarthrodial joint cannot bear close examination, yet for convenience it may be retained, for it seems certain that the movements of the globe are rotations about a centre which remains practically fixed; and, indeed, it may be regarded as an axiom that the axes, round which the several pairs of muscles rotate the eye, pass through the fixed central point.

The chief factor in maintaining the fixity of the ocular centre is the vascular orbital fat: if this be much diminished the globe sinks back into the orbit, the condition known as enophthalmos; if the vessels be over-full, the eye becomes prominent. This vascular engorgement is the chief cause of the prominence in arterio-venous aneurism: occasionally we may meet with patients in whom the eyes are alternately sunken and protruding, as the orbital vessels are empty or full.

One other point seems to throw light on the importance of the fat as the chief factor in maintaining the equilibrium of the eye: all the extrinsic ocular muscles tend to pull the globe towards the inner wall of the orbit. This can easily be seen from any diagram, which will show that the resultant of the forces of the recti and obliqui must be a force acting towards the inner wall. As a matter of fact, the globe does not undergo any such transportation as would seem required by this mechanism; the only resisting structure is the fat.

The muscles, though they no doubt play an important part in preserving the equilibrium, are not essential; they may be completely paralysed without giving rise to any misplacement of the globe. The elastic ligaments and the other fascial structures which we have already described assist to a varying extent.

We may, then, for convenience regard the fat as forming a cup in which the globe plays.

The axis of rotation of any pair of muscles may be described as a line lying either in the vertical or horizontal plane, passing through the centre of the eye at right angles to the muscles in question. Thus in the case of the lateral recti, the axis of

rotation is a vertical line through the centre of the globe, and all movements of the eye due to these muscles alone take place round this imaginary axis. In the case of the other pairs of muscles the arrangement is not so simple; since the long axis of the superior and inferior recti is not parallel to the sagittal plane of the body, but oblique, their axis of rotation is not at right angles to the visual axis, but forms an angle of about 63° with this. Hence the action of these muscles does not rotate the cornea in a vertical line.

The movements of upward and downward rotation are effected by the combined action of the superior or inferior rectus and the inferior or superior oblique muscles respectively. If we consider the movement of the cornea when the superior and inferior recti are thrown into action, it will be seen that each point of the cornea describes a segment of a circle round the axis of rotation; if the superior rectus acts, the cornea moves upwards, inwards, and the vertical axis becomes oblique, so that it is directed downwards and outwards. These movements are most easily understood if a rough model be made, as recommended by Landolt (2).

Take an india-rubber ball, about two inches in diameter; choose any point on its surface, and draw through this point two lines round the globe at right angles; these will serve to represent the horizontal and vertical planes of the eye. With a pair of compasses draw a circle whose centre is the point first selected and whose radius is half an inch; this forms the cornea: a smaller circle drawn concentrically within this will represent the pupil. The vertical axis of rotation may be easily found by taking the middle of the upper and lower vertical semicircles. A steel knitting needle driven through punctures at these points will enable us to show the movements given to the eye by the lateral recti.

The axis of rotation of the vertical recti lies in the horizontal plane at an angle of 63° from the antero-posterior axis. To demonstrate this, we must find a point on the horizontal circumference 1·1 inch from the centre of the cornea, and mark

the opposite extremity of the same diameter 1·1 inch from the posterior pole of the eye; a second knitting needle passed between these points will allow rotation of the globe round the "axis of the vertical recti," and will show the movements of the cornea.

The axis of the obliques lies also in the horizontal plane, and forms an angle with the sagittal axis of 39°; therefore its anterior extremity must be at a point on the horizontal circumference of the globe 0·68 inch from the centre of "cornea" in our model.

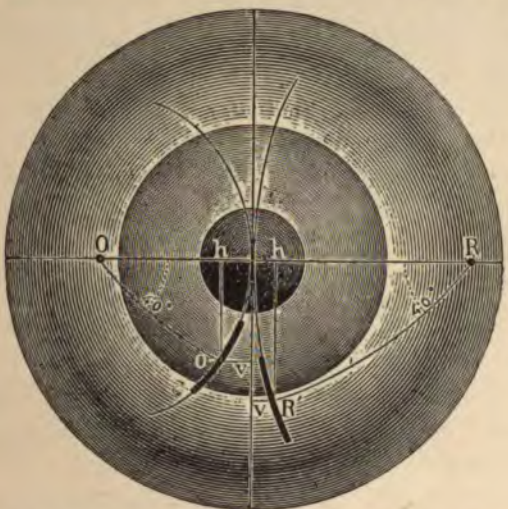

FIG. 2.—Model to show movement of cornea produced by the action of single muscles. (By permission of Prof. Landolt.)

When the eye is rotated by any one of the muscles, the movement of the centre (or any other point) of the cornea describes an arc of a circle whose centre is at the axis of rotation. If, for example, we wish to represent the movement of the corneal centre under the influence of the obliques, we must draw on the ball a circle, by means of a pair of compasses having the fixed leg at the extremity of the "oblique" axis, O, and the other at the centre of the cornea. The superior oblique will effect any movement *below* the horizontal meridian, the inferior, all movement above the horizontal meridian.

If we wish to find the position of the cornea when the muscle has rotated the eye 40°, we must draw on the ball a line O O′, making the angle R O O′ equal to 40° and cutting the circle at O′; then the point O′ will show the position of the centre of the cornea, and a line drawn through this point at right angles to O O′ will show the position of the vertical diameter of the cornea.

Similarly, if we wish to demonstrate the movement of the corneal centre, when acted on by the vertical recti, we must draw a circle having the centre R and the radius equal to the distance between this point and the centre of the cornea. By a rotation of 40° the centre of the cornea moves to R′. Since the radius of the latter circle R R′ is greater than O O′, the radius of the former, the movement of the cornea for a given angular rotation is greater for the recti than for the obliques; in either case, as the diagram shows, the centre moves not only from the horizontal, but also away from the vertical meridian; by letting fall perpendiculars, O′*v*, O′*h*, and R′*v*, R′*h*, from the points O′, R′, respectively, to the vertical and horizontal meridia, we can measure directly the amount of motion in each sense.

These remarks make clear the difficulty of treating vertical displacements, since there are two muscles concerned in every vertical movement, and one only can be dealt with.

We shall now pass on to the consideration of the special cases.

Squint

Concomitant squint, for our immediate purpose, may be defined as a permanent want of parallelism of the visual axes, without any loss of muscular power. To whatever cause due, it eventually leads to contracture of one muscle and stretching of its opponent. In early stages it disappears under general anæsthesia; when contracture has set in, however, the change in position, even with complete muscular relaxation, is not sufficient to effect complete correction.

The deviating eye is usually very defective as regards vision,

and, therefore, any operation which is undertaken for the correction of squint must, in the large majority of cases, be simply cosmetic.

Since a squint sometimes disappears spontaneously even during adult life, no operation should be undertaken until it is fairly certain that the defect is likely to be permanent.

For surgical purposes the division of concomitant squint into convergent and divergent is important, since their treatment differs in many respects; we shall deal first of all with convergent strabismus.

Interference with the contracted muscle is the leading feature of the earlier plans of operation for strabismus. The methods fall into several minor groups, of which the following is a tabulated arrangement:—

Group 1.—Division of the muscle or tendon and overlying conjunctiva.

(*a*) Division of the muscle itself.
(*b*) Division of the tendon.
(*c*) Parascleral tenotomy.

Group 2.—Subconjunctival tenotomy.

(*a*) Using the squint hook.
(*b*) Without the squint hook.

Group 3.—Tenotomy with reattachment.

Group 4.—Multiple partial tenotomy.

Group 5.—Lengthening without division of the muscle.

(*a*) By stretching.
(*b*) By division of the fascial attachments.

In the treatment of convergent squint, the operation of tenotomy was the earliest method, and is still that most commonly employed for the correction of the deformity. Even this operation is of comparatively recent date. It would seem an obvious surgical expedient to attempt to relieve the contracture of the muscle by division, yet it was only about 1839 that this was done first. It is true that it has been claimed for the Chevalier Taylor (a skilful but somewhat irregular practitioner of the eighteenth century) that he cured squint

by this operation, but there seems little doubt that this claim cannot be substantiated; the honour of the first operation for strabismus, then, rests with Dieffenbach (3). The suggestion was made by White about 1827, but forgotten, and revived by Strohmeyer in 1838.

GROUP 1 (*a*).—Division of the muscle through a free incision. This, the original method of Dieffenbach, is only of historical interest. The muscle was exposed freely and the muscular belly divided. The operation failed in two respects: in the first place, the two parts often refused to unite, and the power of the muscle was lost; in the second, the operation opened very freely the cellular tissue of the orbit, and exposed the patient to the risk of orbital cellulitis. It, therefore, was falling into disrepute when von Graefe proposed division of the tendon. Dieffenbach soon recognised the value of this suggestion; even in 1842 he speaks of "division of the muscle or the tendon."

Von Graefe (4) drew the tendon out of the wound and divided it; the traction seriously disturbed the fascial connections.

It was in the attempt to preserve the normal relations between the muscle (including the tendon) and the fascia that Critchett devised his method of subconjunctival tenotomy. In this method a small wound is made at the border of the tendon, the squint hook is passed in under the tendon, and this is lifted away from the globe. Then the scissors are passed through the wound and the tendon divided, without any great damage to the fasciæ, and practically none to the conjunctiva. It was difficult to estimate exactly the result of this procedure, which, further, was often followed by retraction of the caruncle from the tension of the elastic ligaments when the internal rectus muscle was divided. To relieve this deformity, Koster suggested that careful dissection of the conjunctiva towards the canthus would allow the muscle to retract after division while keeping the caruncle normally prominent. His operation (*q.v.*) lays great stress on this point; but in separating

the elastic ligaments, we cause the patient to run an increased risk, that the muscle will lose all attachment to the globe. Delamare has recently gone back to a procedure allied to that of Dieffenbach, thinking that the tenotomy of the usual kind often fails to effect the readjustment of squints of large angle. He therefore divides the tendon at some little distance from its insertion, approaching the muscular fibres as he desires a greater effect, and keeping close to the sclerotic for a lesser. This he calls parascleral tenotomy.

Some surgeons have blamed the squint hook for the occasional divergence following the division of the tendon, thinking that it is due to the disturbance of the fasciæ during the passage of the hook; hence Koster and others strongly advise that the hook should be abandoned in these procedures. It does not seem likely that a single introduction of a smooth hook could greatly disarrange the fascia; and, on the other hand, subconjunctival tenotomy in the usual mode is quite impossible without a hook: if he wish to dispense with this, the surgeon must divide the conjunctiva to some extent directly over the insertion.

All these procedures which we have been mentioning essentially consist of free division of the contracted muscle, which is allowed to retract at its own pleasure: it may or may not regain a useful attachment to the globe.

The absence of muscular tension will permit the globe to protrude, immediately after the operation, pressed forward by the orbital fat; the new insertion, if it is made, will be situated far back on the sclerotic, and in this way the action of the muscle will be seriously limited. The retraction being lessened by the elastic ligaments, it is most inadvisable to interfere with these largely, as is often done in such operations as Koster's.

The student sees at once that the action of the ocular muscles is kept steady and equal, because, so long as their insertion is in front of the transverse plane of the body, their lever of rotation is the radius of the globe. Since this is always equal, their power is also equal. But if their insertion falls behind

the transverse plane, the length of the lever becomes less and less, and the power of the muscle is no longer exerted equally.

If, by some such operation as we have been considering, the insertion is set back a long way, it may never be in front of the transverse plane, and as the globe rotates, it will steadily diminish the mechanical advantage. For these and other reasons, the operation of simple tenotomy is not so commonly performed now as it was in former time; surgeons have tried to rid it of its inherent defects in different ways. Some, as Sydney Stephenson, lengthen the tendon by oblique division and reattachment, or supply an artificial tendon of silk: this method is free from many of the objections which were urged against simple tenotomy. It allows accurate adjustment of the deformity, and ensures the reattachment of the muscle.

Verhoeff lengthens the tendon by multiple partial division: this would seem to be a difficult operation, and in no way superior to that of Stephenson. Others advise stretching of the fascial connections without division. These last methods are little used.

The final result after a tenotomy is seldom that which is seen at the time of operation. Either the squint recurs as the new attachments strengthen, or if the muscle have been entirely separated from the sclerotic, the opponent pulls the globe further and further round.

By one of these operations of tenotomy it is possible to correct a deviation of some 18° or 20° when we are dealing with convergence (or 35° to 40° if both eyes are attacked). When we require to correct any other form of deviation, the effect of a tenotomy is much less. This will be again alluded to below.

Table of Operations on the Contracted Muscle.

Group 1.—Division of the muscle or tendon, with the conjunctiva and fascia overlying.

(*a*) Division of the muscular belly (Dieffenbach).
(*b*) Division of the tendon (von Graefe, Mules).
(*c*) Parascleral tenotomy (Delamare).

Group 2.—Subconjunctival tenotomy.

(*a*) Method with squint hook (Critchett, Bell Taylor).

(*b*) Method without hook (Koster); graduated tenotomy (Stevens).

Group 3.—Tenotomy with reattachment.

Method of Stephenson, Landolt.

Group 4.—Multiple partial tenotomy.

Method of Verhoeff.

Group 5.—Lengthening without division of the muscle.

(*a*) Stretching the muscle (method of Carmalt).

(*b*) Division of the capsular attachments (Parinaud, Motais).

Group 1 (*b*).—Some surgeons are accustomed to make the preliminary incision through the conjunctiva, over the insertion of the muscle. This method was introduced by von Graefe.

Von Graefe's Operation (4)

Instruments.—Speculum, fixation forceps, scissors, squint hook.

First Stage.—The surgeon picks up in the forceps a fold of conjunctiva horizontally over the insertion of the muscle, and divides it with the scissors, thus making a vertical wound close to the cornea. This incision goes through the fascia as well as through the conjunctiva.

Second Stage.—Into this wound he passes the squint hook, and, lifting up the tendon on it, draws it out of the wound.

Third Stage.—He divides the tendon with the scissors.

A slight modification of this procedure was suggested by Mules, and recommended for its rapidity.

Mules' Operation (5)

The same instruments are required.

First Stage.—The surgeon picks up a horizontal fold of conjunctiva over the centre of the insertion of the muscle and thrusts the points of a pair of scissors into the lower side of it, penetrating

the lower layer of the conjunctiva; the points are then separated, so that a funnel-shaped space is made under the conjunctiva, over the upper part of the tendon, having only a small opening at the point of insertion of the scissors.

Second Stage.—Into this space is passed the squint hook until its point reaches the upper border of the tendon. Then by a twist it is brought under the tendon.

Third Stage.—One blade of the scissors is passed, alongside of the hook, under the tendon, and all the structures between the blades are divided at one cut.

GROUP 1 (*c*).—Delamare (6) has recently proposed a method which may be considered a reversion towards Dieffenbach's operation.

He points out that tenotomy of the usual kind often fails to effect the readjustment of squints of large angle, and that Dieffenbach's operation was given up because of its excessive action. He thinks that by dividing the tendon at some little distance from its insertion into the sclerotic we may obtain an effect intermediate between the two. He calls his procedure PARASCLERAL TENOTOMY.

Delamare's Operation

The usual instruments.

First Stage.—The surgeon picks up a horizontal fold of conjunctiva over the insertion of the tendon and divides it with scissors, making a vertical wound, about 10 mm. long, about 10 mm. away from the cornea. He picks up the edge of conjunctiva in the forceps and undermines the conjunctiva, freeing the muscle from the superjacent tissues.

Second Stage.—He then passes the hook under the muscle and lifts it well away from the globe. Then placing one blade of the scissors under the tendon, he divides it about 2 or 3 mm. from the insertion.

He states that the result of this method is considerably greater than that of a tenotomy performed at the usual place;

if this be so, the increase is probably due to the free separation of the muscle from the surrounding structures, effected at the end of the first stage.

GROUP 2.—Critchett (7), in 1855, described the method of subconjunctival tenotomy which is still in common use.

Critchett's Operation of Subconjunctival Tenotomy

Instruments.—Speculum, fixation forceps, squint hook and scissors.

First Stage.—The surgeon picks up with the forceps a small vertical fold of conjunctiva over the lower part of the tendon

FIG. 3.—Subconjunctival tenotomy. *First stage*: division of conjunctiva.

of the muscle, and cuts through it with scissors so as to make a horizontal incision, about 5 mm. long, just below the lower border of the muscle. If the scissors are kept opening and shutting in a plane tangential to the globe, there can be no risk of wounding the sclerotic. The first cut often goes through the Tenon's capsule as well as the conjunctiva, and allows the points to sink freely into the space; if it does not, the surgeon will pick up the fascia with the forceps and divide it separately.

Second Stage.—The hook can now be easily introduced into Tenon's space, and passed under the tendon to be divided. This is lifted away from the globe ; the scissors are then passed

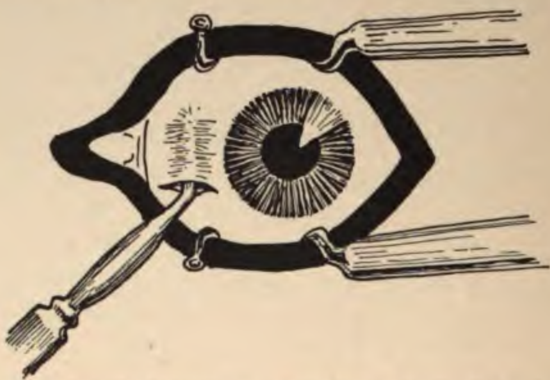

FIG. 4.—Subconjunctival tenotomy. *Second stage* : passage of squint hook.

into the wound, so that one blade is on each side of the tendon, and divide it by one or more cuts. It is usually necessary to divide several strands of fascia running to the tendon from the

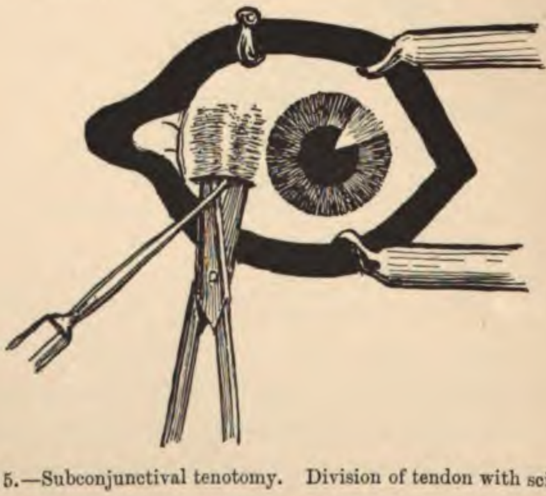

FIG 5.—Subconjunctival tenotomy. Division of tendon with scissors.

capsule before the hook will pass the cut insertion and come forward to the sclero-corneal junction.

Critchett pointed out that if the tendon is unusually broad, the

upper strands are apt to escape from the hook; to avoid this, he advised the surgeon, when he found the tendon broad, to make a second incision above the muscle and to cut downward from this. The two incisions will, he says, allow the escape of the effused blood.

This second incision has been used by Bell Taylor (8) as a routine method: he having made the usual incision and inserted the hook in the usual way, makes the end appear prominently under the conjunctiva above the tendon and cuts down on it, from above; then he divides the tendon downwards with scissors.

Group 2 (*b*).—The primary aim of this sub-group is to avoid disturbance of the fascial connections of the muscle, by leaving out the squint hook. The tendon is picked up in forceps, and divided cautiously; the method is chiefly used by American surgeons in the treatment of heterophoria, and Stevens' method will be described in a later part of this chapter, under the heading of heterophoria.

Koster (9), however, uses the method, combined with free division of Tenon's capsule, for the surgical treatment of ordinary convergent strabismus.

Koster's Operation

Instruments.—Speculum, fixation forceps, scissors.

First Stage.—The surgeon picks up a vertical fold of conjunctiva over the tendon and divides it with the scissors, so as to make a horizontal incision over the centre of the tendon, some 6 or 7 mm. in length.

With the scissors he frees the conjunctiva round the incision from the subjacent parts, and, if operating on the rectus internus, pays special attention to the caruncle. If the bands running from the muscle sheath to this structure are detached, the subsequent retraction is reduced to a minimum.

Second Stage.—He then seizes the tendon in the fixation forceps and divides it in the centre; then, passing the scissors

into the opening, he cuts upwards and downwards in succession, so as to divide each half of the tendon. The incisions are carried past the tendon into the capsular fascia above and below.

If an unusually large effect is required, two divergent incisions are made in the fascia from each border of the tendon after division of this. The conjunctival wound is closed by a suture.

GROUP 3.—The manifest uncertainty of the result of simple tenotomy, and the impossibility of accurate dosage, have led surgeons to seek a way of robbing it of its defects.

Sydney Stephenson's (10) Method of Lengthening Tendons

This was the first attempt at accurate adjustment, and is free from many of the disadvantages of the older operation.

The surgeon lays bare the tendon of the muscle by slight dissection, and divides it either obliquely by a single long cut, or by the method shown in the diagram (fig. 6), and then re-attaches the parts of the tendon so as to lengthen the muscle by the amount desired.

The second method may be thus described. The surgeon, having measured the linear deviation, divides the lower half of the tendon by a vertical incision close to the globe, and then, at a distance on the tendon equal to the deviation of the eye, makes a second vertical incision through the upper half; the two vertical incisions are joined by a horizontal one, and the ends adjusted so as to allow the rotation of the globe to the required extent.

This operation is a considerable advance on simple division; two points, however, occur as possible objections. In the first place, the linear measurement of the squint is not quite the same as the amount of lengthening required—and the error is greater with the increase of the squint—and, in the second, the direction of the chief action of the muscle is shifted slightly, and thus there will be a tendency towards hyperphoria.

Since, however, the operation is usually only cosmetic, this is not an important matter, and could be easily overcome by dividing the tendon into three parts and stitching the upper and lower to the middle, as in the diagram (fig. 6A).

By such a method a slight amount of deviation can be

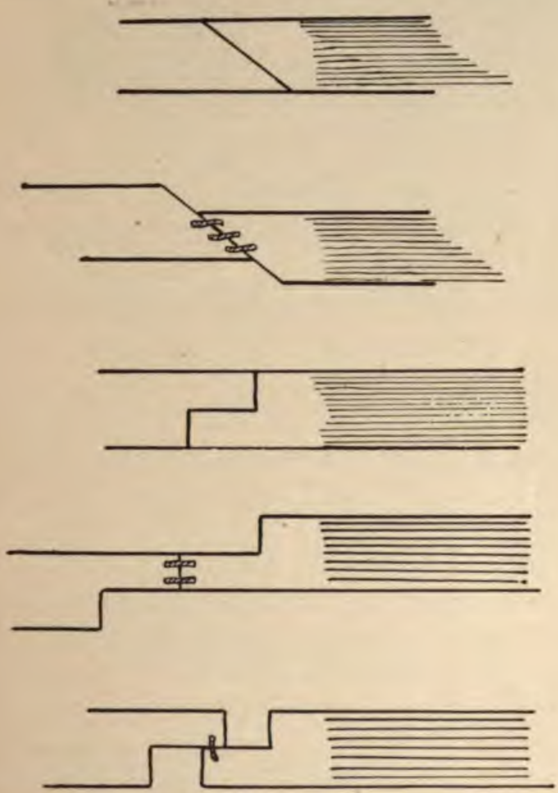

FIG. 6.—Stephenson's operation for lengthening tendons. The upper two figures show oblique divisions and re-attachment; the third and fourth, Stephenson's second method; the fifth, Landolt's method of re-attachment.

corrected with considerable accuracy, especially if the fascial connections are stretched by rotating the eye forcibly in the opposite direction with the aid of squint hook before the tendon is divided.

A tenotomy after one of these methods will correct up to

18° or 20° convergence. By operating on both eyes we may correct a total deviation of about 40°. Landolt has recently described a precisely similar procedure.

GROUP 4.—Operation of multiple partial tenotomy.

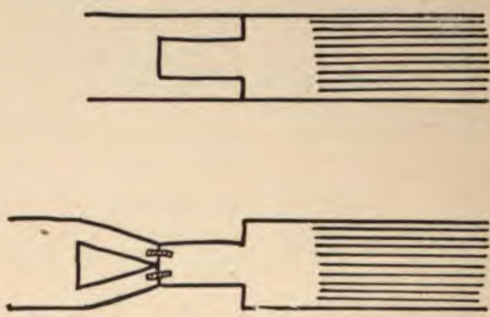

FIG. 6A.—Modification of Stephenson's operation.

Verhoeff (11) lengthens the tendon without completely dividing it, as follows:—

First Stage.—The tendon is exposed with some freedom.

Second Stage.—The surgeon makes, close to each end of the

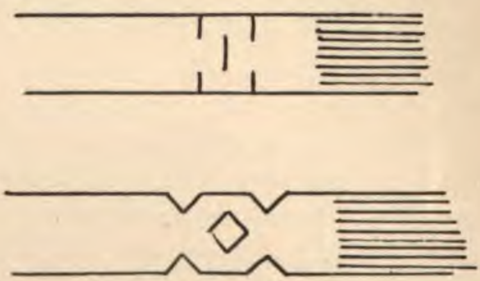

FIG. 7.—Verhoeff's Operation.

tendon, small incisions in the upper and lower borders, involving about a fifth of the breadth; midway between these pairs of incisions he makes a vertical incision extending through the two middle quarters of the tendon. In this way the whole is lengthened, without complete division.

In this procedure the final result is less than that attained at the time of operation, because the contraction draws the parts of the tendon together.

GROUP 5.—These methods have not been much adopted, and their value is uncertain.

Carmalt (12) narrates how he is accustomed to seize the muscle in forceps, and to rotate the eye forcibly against the muscle, stretching the latter and its fascial connections.

Fox passes a squint hook under the muscle and stretches with this; he usually excises a piece of Tenon's capsule.

Parinaud (13) advocates separation of the fascial and capsular connections as a means of correcting small deviations, and Motais (14) describes a method of dividing the alar ligaments with the same object.

In the higher degrees of convergence a tenotomy is not sufficient to correct the deformity, and even in the lesser degrees the surgeon, having regard to the disturbance which necessarily follows the uncontrolled division of a tendon, may prefer to increase the opportunity of the over-stretched muscle by advancing its insertion, instead of dividing the contracted fibres.

We have seen that in concomitant squint there is no loss of power in the muscles, but only a faulty direction of the visual axis. If we can swing the globe round within the group of muscles, so as to alter its direction without altering the relations of the muscles one to another, we shall have succeeded in removing the deformity and giving a cosmetic cure.

This is our aim in the various operations for advancement—to bring forward the insertion of one muscle and to rotate the globe so far as to correct the deviation. It is clear that to shorten one muscle and to leave the opponent of its original length would tend to press the globe back into the orbit and would produce enophthalmos, just as an ill-advised tenotomy, by lengthening one muscle, allows proptosis. The orbital contents offer considerable resistance to any backward displace-

ment of the eye, and if a large advancement were attempted, the tension on the stitches would be extreme. Probably in such event the new attachment would be torn away. It is necessary, therefore, to combine an advancement with division or lengthening of the contracted opponent.

In minor deviation, and especially in divergence, it has been suggested that an advancement of Tenon's capsule alone might suffice. The idea is that by excising a piece of the capsule over the stretched muscle, this may be brought forward and the direction of the visual axis altered, without any interference with the actual insertions. Webster Fox has published the results of a series of cases in which he employed this method with success.

In larger deviations the muscles must be attacked.

Critchett's operation was first devised to correct the evils following tenotomy when the muscle did not succeed in forming a new attachment. The muscle was sought, its anterior end refreshed, and stitched again to the globe at the selected point. Three sutures are passed; the central one is the most important. It must pass through the muscle midway between the upper and lower borders, and take a firm hold on the sclerotic close to the end of the horizontal diameter of the cornea. Since the sutures pass simply through the muscle, they sometimes cut out prematurely; to prevent this, Worth recommended that part of the tendon should be held by a half knot.

The upper and lower sutures, when several are used, diverge toward the ends of the vertical diameter of the cornea.

The chief disadvantage of all these methods, in which the sutures take a divergent course from the upper and lower borders of the tendon to the upper and lower margin of the cornea, is that the tension of the stitches can rarely be made equal, and the tendon is, therefore, usually pulled either upwards or downwards into a position of heterophoria. Further, not very infrequently one suture cuts through, and the second pulls the tendon very obliquely.

To remedy this, while retaining the double suture, Valude

suggests that we should split the tendon for some millimetres horizontally after its detachment, and reattach each half separately to the globe.

Since it is very difficult or even impossible to judge the permanent from the immediate result of any such operation, Prince and others have suggested that the sutures should not be tied firmly at once, but left in a bow knot; they then readjust the tension on the muscle at some later time, within forty-eight hours. It does not seem wise to tear away the newly-formed attachments of the tendon, as this necessarily does, and it would appear to give an increased risk of failure of all union: the procedure has been recommended by some distinguished and careful surgeons, but is not likely to win general acceptance.

Another method of suturing is to pass a loop of silk through the muscle in such a way as to take a firm hold on it, and to secure both ends of the loop to the episcleral tissue at some selected spots. The muscle is able to play a little on the loop, and can thus readjust itself if necessary, with relation to the horizontal meridian. A good form of this method is that of Williams (*q.v.*).

In all these operations the muscle is either divided or resected as may be needful; division of the tendon only causes less interference with the fascial relations and connections, but when Prince's forceps have been used, the part of the muscle in their grasp is so bruised that it is advisable to resect it. When the muscle has been divided, there is always some fear that it may remain entirely separate from the eye, and the last stage of the case become worse than the first. Many surgeons now, therefore, do not advance the insertion of the muscle, but shorten it by folding it on itself. In this way they avoid all risk of making the patient worse; if the muscle to be advanced be divided, there is always the possibility that no new attachment be formed, and the deformity be actually increased. If the muscle be not divided, this at least cannot happen.

Some surgeons, if they think that the immediate effect of an

operation is insufficient, will fix the eye by means of a suture, in an exaggerated position, so as to prevent the recurrence of the deformity which usually appears during healing. This suture is often so placed as to lie straight across the cornea; but this membrane does not seem to suffer therefrom.

This fact disposes of one objection urged sometimes against Williams' operation, that the suture at the corneal margin may do damage. After a considerable experience we can say that we have never seen any hurt.

Advancement Operations

Group 1.—Advancement of capsule with stretching of opponent (method of Webster Fox).

Group 2.—Reattachment of a divided muscle with or without resection.

- (*a*) Attachment by multiple sutures (method of Critchett, Worth, Valude, Jocqs, Landolt).
- (*b*) Attachment by a loop (method of Williams, Prince, Lindo Ferguson).

Group 3.—Folding of the muscle without division (musculo-capsular advancement) (method of De Wecker).

Group 1.—In minor deviations, and especially in divergence, some such procedure as that recommended by Webster Fox may be tried.

Webster Fox's Operation (15)

The instruments needed are speculum, squint hook, special broad fixation forceps, scissors, and needles.

The *First Stage* of the operation is stretching the fascial connection. The operator, standing on the same side of the eye as the muscle to be advanced, makes a small incision into Tenon's space, below the margin of the opponent Under the tendon he passes a squint hook and rotates the globe forcibly, so as to overcome the existing deviation ; afterwards he divides the tendon on the hook.

The *Second Stage* consists in picking up with broad-bladed forceps the tissues over the muscle, at a point midway between the cornea and caruncle; by raising the forceps two or three times it is easy to separate the conjunctiva and subjacent tissue from the muscle. The fold thus picked up is cut off by a single sweep of the scissors, leaving an elliptical wound, at the bottom of which is seen the muscle.

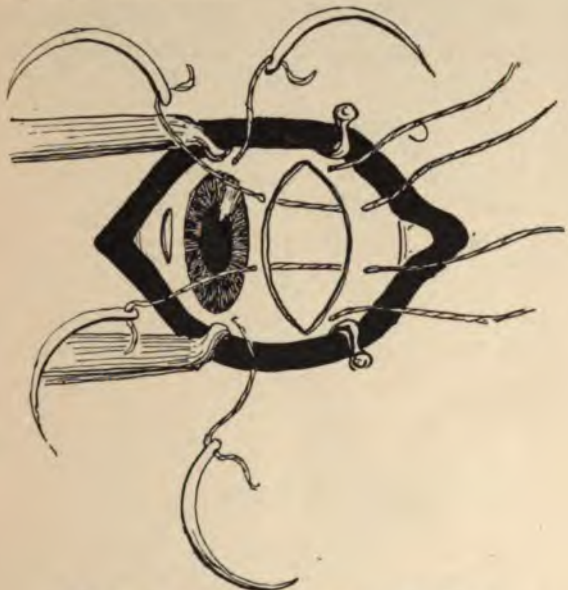

FIG. 8.—Webster Fox's operation. *Final stage.*

Lastly, three or four sutures are passed through conjunctiva and capsule on each side of the incision across the wound, which is closed when they are tied.

In most cases, however, the insertion of the muscle must be advanced, and for this several operations have been suggested.

GROUP 2 (*a*).—Attachment by multiple sutures.

Critchett's Operation (16)

Critchett's operation for advancement has undergone many modifications of little importance since it was first devised.

The operation is still performed almost as its originator described.

The instruments required are speculum, fixation forceps, straight strabismus scissors, Prince's forceps, squint hook, needles and needle-holders. The needles used are best No. 20, silk No. 0.

The operation may be considered in four stages:—

First Stage.—Exposure of the Tendon.—The tendon of the muscle to be advanced is exposed by a vertical incision over it, about 5 mm. from the cornea. Under it is passed the female

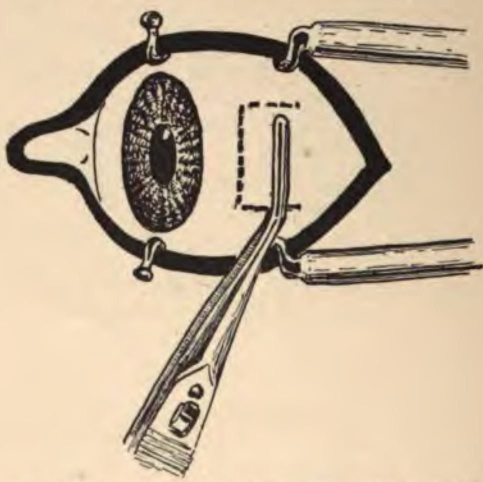

FIG. 9.—Critchett's operation—modification. The dotted lines show incisions to separate the tendon.

blade of Prince's forceps; the male blade remains on the outer surface of the conjunctiva. The tendon, capsule, and conjunctiva are all grasped firmly by closing the blades. This method interferes somewhat seriously with the fasciæ; it is less disturbing to make a small incision at the border of the muscle, as in subconjunctival tenotomy, and pass the inner blade of the forceps through this, under the tendon.

The *Second Stage* consists in separating the muscle from the globe. The tendon is divided on the ocular side of the forceps, and two small horizontal incisions are made through conjunctiva and capsule along the upper and lower edges of the muscle.

Third Stage.—The Passage of the Sutures.—Three very fine needles armed with fine silk are passed through conjunctiva,

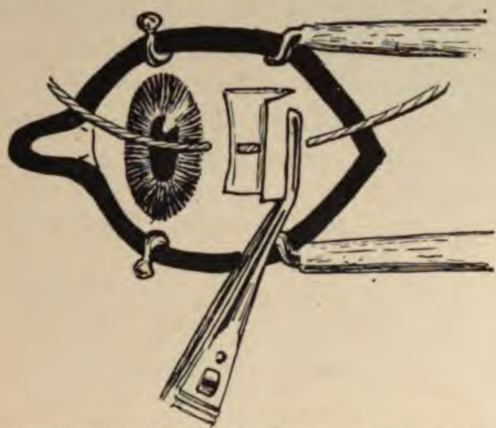

FIG. 10.—Critchett's operation. *Third stage*: passage of central suture.

capsule, and muscle, one in the centre and one at each end of a vertical line whose position has been estimated by the

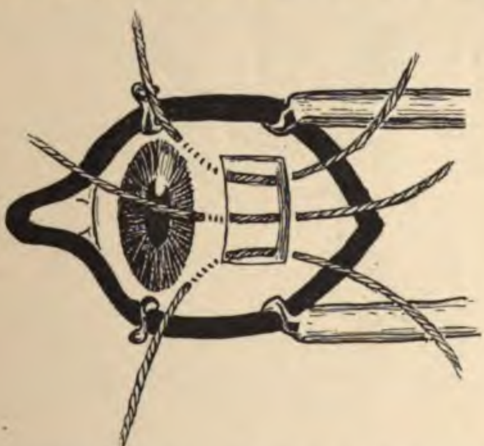

FIG. 11.—Critchett's operation. *Fourth stage*: all sutures in position, and tendon resected.

operator, and then passed under the conjunctiva to the margin of the cornea, diverging slightly and picking up a little superficial scleral tissue just before their exit.

Fourth Stage.—The portion of muscle and conjunctiva held in the forceps is cut off and the sutures tied; the horizontal one is tied first, and the muscle thus adjusted in the vertical plane before the upper and lower threads are secured. The sutures practically close the conjunctival wound.

Another good method is that of Worth, which is a slight variation of Critchett's original operation.

Worth's Operation (17)

The instruments required and the first stages of the operation are practically the same as in the parent method.

The difference lies in the mode of suturing for the reattach-

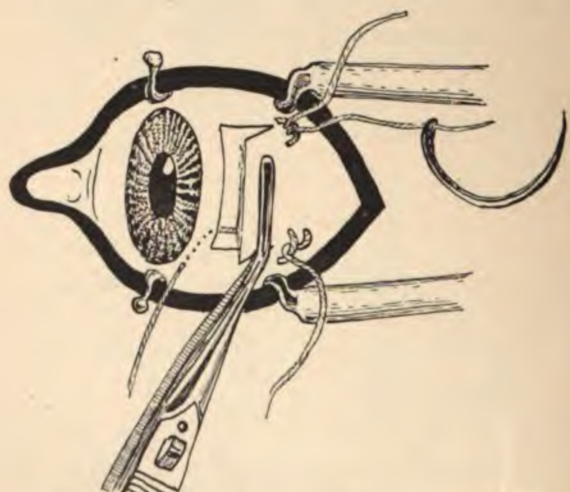

FIG. 12.—Worth's operation. *Third stage*: The passage of the lower suture is complete; the upper has passed through muscle only.

ment. Having exposed the tendon and divided it, held in Prince's forceps as just described, we pass to the *Third Stage* of the method.

Holding the tendon away from the globe, the surgeon passes two sutures in the following way:—A small curved needle is made to pierce the conjunctiva and capsule just above the

upper edge of the muscle, and is then pushed under this edge and made to traverse muscle, capsule, and conjunctiva on its way to the surface. There is now a loop of silk beneath the muscle, whose two ends emerge pretty close together on the conjunctiva. These ends are tied in a half-knot. A similar suture is passed under the lower edge of the muscle and tied in the same way; the position of these sutures will vary with the amount of squint, as described above. The portion of tissue held in the Prince's forceps is then cut away with scissors, and the needles, still carrying the sutures, are passed again through the muscle and forwards under the conjunctiva on the corneal side of the wound, picking up a little episcleral tissue before their exit close to the vertical diameter of the cornea.

When the ends of each suture are tied, the part of the muscle held in the half-knot is dragged forward to the margin of the cornea and held there.

The disadvantages of Critchett's operation are that the hold of the sutures on the muscle is slight, and may give way, and that some conjunctiva is removed unnecessarily; this last point could be easily avoided, but it is of little importance. The central adjusting suture is of value, and it is a drawback to Worth's operation that it has been given up.

The better hold of the sutures in the latter is a real gain.

Landolt's Operation

Landolt (18) lays great stress on the importance of not disturbing the capsular relations of the muscle in the early stages of operation. The same instruments, with exception of Prince's forceps.

First Stage.—The surgeon lays bare the muscle by a U-shaped incision placed horizontally over the insertion, and dissects up the conjunctiva.

Second Stage.—He then picks up the capsule at the lower border of the muscle and makes a small horizontal incision; through this he inserts the squint hook under the tendon.

Third Stage.—He then passes two sutures through the muscle at a point varying with the degree of squint. The position of the two sutures divides the muscle into three equal parts from above downwards.

Fourth Stage.—He then divides the muscle, and if the squint is large, detaches the tendinous end from the sclerotic.

Fifth Stage.—Having raised the muscle by the sutures, to see that it is free from all attachment to the globe, he fixes the sutures to the episcleral tissue in the usual way.

Jocqs' Operation

Jocqs (19) describes an operation very similar to Critchett's, and calls it musculo-capsular advancement, though this term

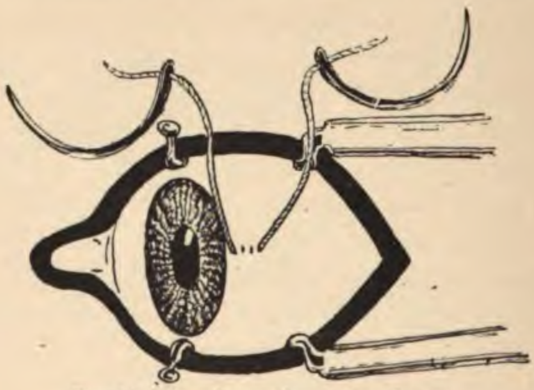

FIG. 13.—Jocqs' operation. *Second stage.*

is usually applied only to those methods which do not involve division of the muscle. The same instruments, with the exception of the squint hook, which Jocqs does not employ.

First Stage.—A guarded tenotomy of the opponent.

Second Stage.—A suture armed with two needles is passed horizontally opposite the centre of the muscle to be advanced through the episcleral tissue, between the cornea and the insertion of the tendon. This suture must have a firm hold on the sclerotic, since the success of the operation depends on it.

Third Stage.—A horizontal incision is made over the tendon

through the conjunctiva, and this membrane is dissected away from the field of operation without being removed.

Fourth Stage.—The surgeon picks up the tendon together

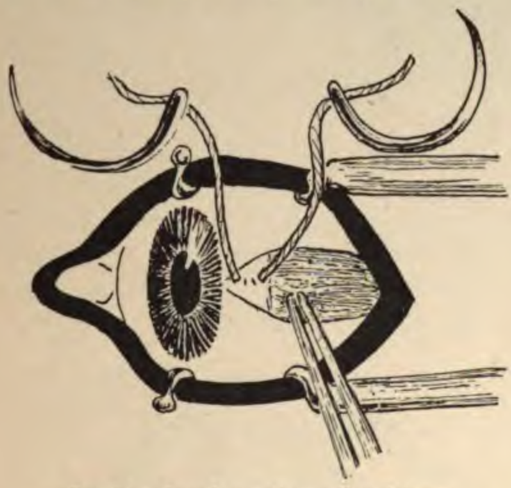

FIG. 14.—Jocqs' operation. *Fourth stage.*

with the overlying capsule with a pair of toothed forceps, and cautiously divides it with scissors: the amount of detachment will vary with the effect to be produced.

Fifth Stage.—Still holding the tendon in the forceps, the

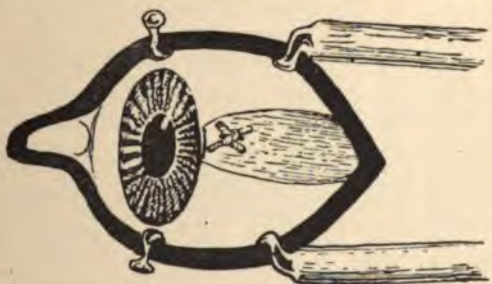

FIG. 15.—Jocqs' operation. *Fifth stage*: re-attachment of muscle.

surgeon passes the two needles through it from the deep surface to the superficial in the horizontal plane, making the punctures at least 3 mm. apart. The muscle is drawn towards the cornea and the suture tied without any tension on the silk.

Sixth Stage.—After tying this central suture, the surgeon passes two others, one at each edge; these do not take hold of the tendon, but only of the capsule. They are carried subconjunctivally almost to the vertical diameter of the cornea, and tied.

Valude's Operation

Valude (20) points out that there is one great danger in the operations of the last class, in which the chief sutures diverge from the upper and lower border of the tendon to the upper and lower ends of the vertical meridian of the cornea. There is a risk that one or other may cut out, leaving the muscle attached by its upper or lower border only. This will give

FIG. 16.—Valude's operation. The halves of the split tendon reattached separately.

rise to an abnormal rotation or cyclophoria of the globe. He therefore, for the relief of this danger, recommends the following procedure:—

First Stage.—The tendon is exposed, and two sutures are passed, one through the tendon at the junction of the upper and second quarters, the other at the junction of the lower and third quarters.

Second Stage.—The tendon is now divided from the globe, and split horizontally for some 6 or 8 millimetres.

Third Stage.—Each half is now stitched to the sclerotic near the vertical diameter of the cornea.

GROUP 2 (*b*).—Attachment by a loop.

Williams' Operation (21)

Williams' Operation.—This, to our thinking, is the most simple of any advancement operation. It was described by Richard Williams, of Liverpool.

The instruments needed are: speculum, straight scissors, fixation forceps, squint hook, needles (No. 16) fully curved, needle-holder; for the suture, silk No. 1. The operation may be considered in three stages:—

First Stage.—Exposure of the Muscle.—The surgeon, standing on the side of the muscle to be advanced, picks up a vertical

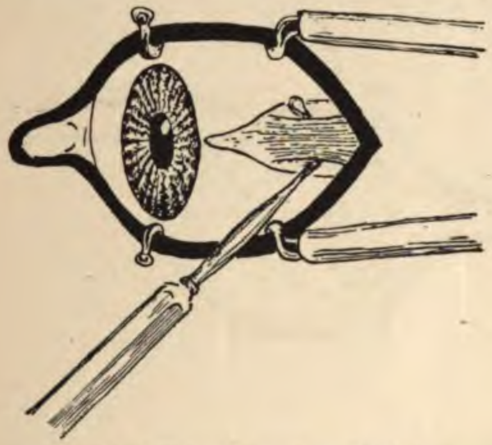

FIG. 17.—Williams' operation. *First stage.*

fold of conjunctiva with the fixation forceps over this muscle near its insertion, and makes with the scissors, opposite the middle of the muscle, a horizontal incision through this fold; then he enlarges the wound towards the canthus and to the edge of the cornea, laying bare the muscle by slight dissections and freeing the conjunctiva above and below the wound by cautious snips of the scissors. He then picks up the muscle on a squint hook and frees it from its surroundings, leaving the insertion intact.

If there is an assistant present, it is advisable to hand the hook over to him at this stage.

Second Stage.—Passing the Suture.—Now, taking the needle, the surgeon introduces it close to the cornea-scleral junction almost in the vertical meridian, and, taking hold at the outset of the superficial scleral fibres, passes it under the conjunctiva, until it emerges at the wound.

He then picks up the muscle, and passes the suture through this, vertically from its upper to its lower border, varying the position with the amount of deviation, choosing a point farther back as the angle of the strabismus is larger; and then, passing the needle under the conjunctiva again at the lower edge of the wound, he makes it emerge at a point opposite the point of

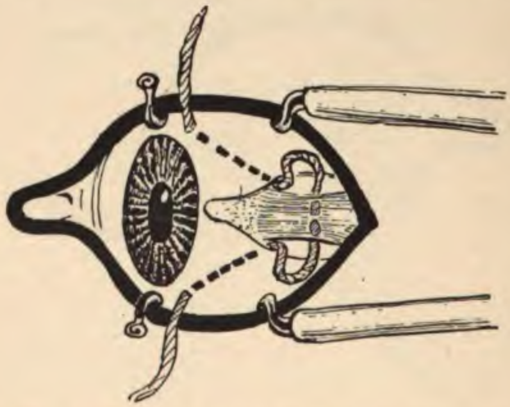

FIG. 18.—Williams' operation. *Second stage*: suture in position.

entrance, picking up the more solid episcleral tissues just before the outgoing.

This suture is not drawn tight; loops of some size are left at each side of the muscle so that the division may be made without risk to the suture.

If the course of the silk be considered, the student will see that it is entirely subconjunctival from entrance to exit, and that it is fixed at each end of its course by the more solid episcleral tissue.

Third Stage.—Division of the Muscle and Reattachment.—The muscle is now divided close to the suture, and the opponent tenotomised if this is thought necessary.

Then the ends of the suture are tied together firmly. The tension on the silk drags the cut muscle forwards under the conjunctiva to the margin of the cornea.

Incidentally, the tying brings up two folds of the mucous membrane, which lie more or less over the limbus, but these are not permanent, and disappear as soon as the suture is removed. It is rarely necessary to stitch up the conjunctival wound.

The advantages of the operation are its simplicity and rapidity (it can easily be done in seven minutes), the few instruments required, and the single suture.

This allows the muscle to adjust itself evenly on the globe, whereas if the upper and lower halves of the muscle are tied separately it is not unlikely that one or other will attach itself above or below its proper level.

Argyll Robertson (22) described a similar operation.

In this he carries the sutures "in and out, over and under the conjunctiva," beyond the opposite border of the cornea.

An operation on almost the same lines was proposed quite recently by a surgeon in the *Wien. Med. Woch.*; we have mislaid the copy and have not been able to verify the reference. The suture, after passing nearly half round the cornea, was wrapped round and through the muscle, encircling it twice, and then was carried round the other half of the cornea: the ends of the suture were tied on the edge of the cornea, opposite to the muscle which was being advanced.

A very similar stitch is recommended by Lindo Ferguson (23), but his procedure is somewhat different in the earlier stages of the operation.

Lindo Ferguson's Operation

Instruments.—Speculum, scissors, fixation forceps, squint hook, Prince's forceps, needles and needle-holder.

First Stage.—The surgeon picks up in the forceps a horizontal fold of conjunctiva over the insertion of the muscle to be advanced, and divides it with the scissors.

Second Stage.—By a slight dissection he exposes the insertion and the greater part of the length of the tendon. He then passes the squint hook under the tendon, and frees it from

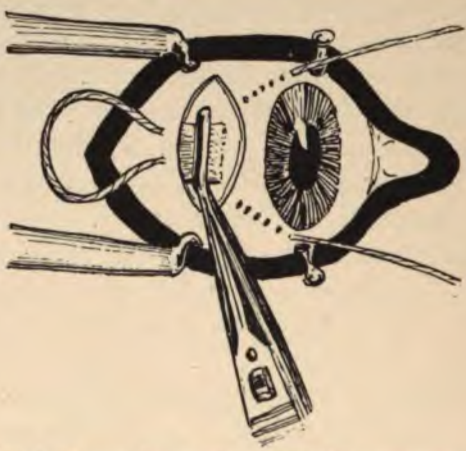

FIG. 19.—Lindo Ferguson's operation. *Third stage*: passage of suture.

the capsule sufficiently to allow him to replace the hook by one blade of Prince's forceps. The other blade lies outside the tendon, beneath the conjunctiva. The forceps are closed and the tendon divided.

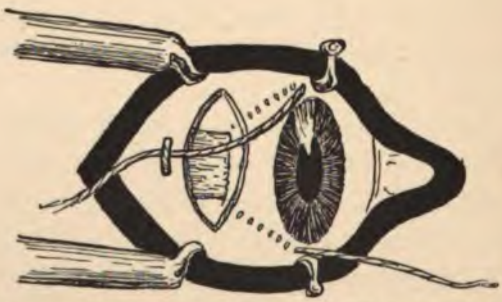

FIG. 20.—Lindo Ferguson's operation. *End of third stage.*

Third Stage.—Now taking a suture armed at each end with a needle, he introduces one needle through the conjunctiva near the outer lip of the first incision, and thence beneath the conjunctiva, to perforate the tendon in its upper part, as far back

as may seem desirable. Thence he passes it, still subconjunctivally, forwards to the upper end of the vertical diameter of the cornea; the other needle is passed in a similar course through the lower part of the tendon to the lower end of the vertical diameter of the cornea. This leaves a loop of suture on the surface of the conjunctiva over the tendon; under this loop the upper needle is passed and the ends tied together. The loop acts as a sort of pulley.

Seeing that it is difficult to judge the effect of the operation for advancement, if it have been performed under chloroform, or any other general anæsthetic, it has been suggested that the final adjustment might be left for some hours until the patient has recovered from the anæsthesia. With this aim, Prince (24) described his method.

Prince's Operation

Instruments.—Speculum, fixation forceps, scissors, squint hook, Prince's forceps, needles and needle-holder.

First Stage.—The surgeon performs a preliminary tenotomy of the opponent, in the usual way.

Second Stage.—Then taking a needle with a suture he passes it through the conjunctiva at a point 1 mm. from the cornea and about 4 mm. below the transverse diameter, and makes it travel upwards beneath the conjunctiva, taking hold on the deeper tissues, until it reaches a point about 4 mm. above the transverse diameter, where it emerges. This suture, anchored to the firm deep tissues, serves as the pulley by means of which the muscle is drawn forward to the required extent.

Third Stage.—The surgeon then makes a small opening in the conjunctiva and Tenon's capsule, just below the lower edge of the muscle to be advanced, and passes in through this aperture the squint hook, under the tendon, which he lifts away from the globe. (Prince, in his original description, makes no use of the squint hook, but inserts one blade of his special forceps at once; these are now often made with teeth

on each blade; if the surgeon try to introduce a toothed blade without the preliminary insertion of the squint hook, he will find the teeth catching in the tissues.) Then he passes alongside of the hook one blade of the Prince's forceps, the other blade remaining on the conjunctiva; when they are closed, they grasp between them the conjunctiva, Tenon's capsule and the tendon.

Fourth Stage.—The surgeon separates the tendon from the

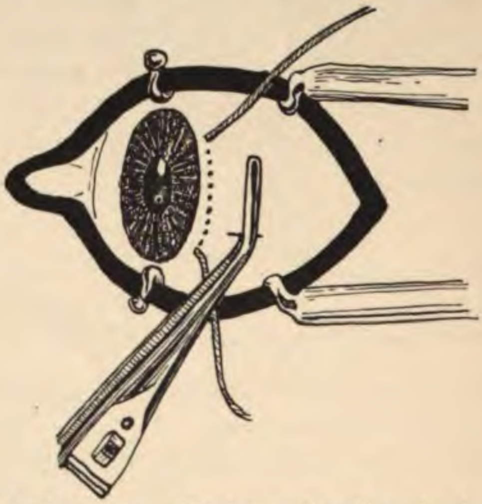

FIG. 21.—Prince's operation. *Third stage*: the pulley suture is in position, and the forceps grasp the tendon.

globe with scissors and dissects it freely back, so that he is able to see the deep surface of the muscle.

Fifth Stage.—Now he takes a suture, armed at each end with a needle, and passes both needles through the flap held in the forceps from the deep surface to the conjunctival, at a position varying with the desired result; thus he has a loop of suture on the deep surface of the muscle which is not likely to give way.

He then cuts away the part of the tendon held in the forceps at a distance of about 2 mm. from the suture.

Sixth Stage.—Laying one end of the second suture across the cornea, he ties the pulley suture over it tightly. When the two

ends of the second suture are tied, the tension on the loop draws the muscle forward to the corneal margin. It is well, Prince says, to tie the second suture in a bow, so that a second adjust-

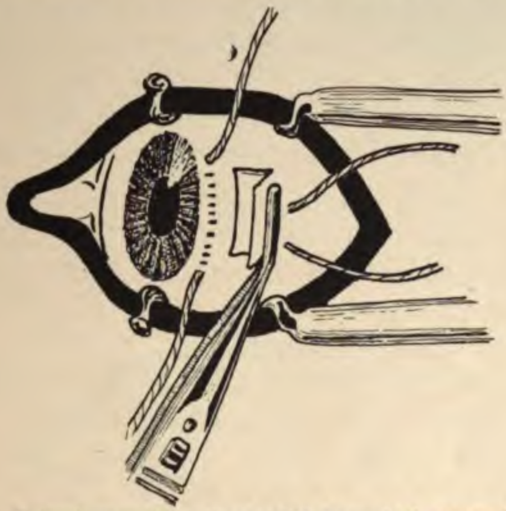

FIG. 22.—Prince's operation. *End of fifth stage*: both sutures inserted.

ment may be made at a later date if it is thought that the first is not satisfactory.

The operation may be varied in the following way, suggested, as Prince records, "by the surgeons of St George's Hospital":—

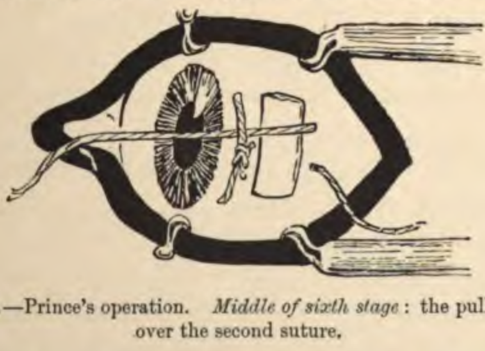

FIG. 23.—Prince's operation. *Middle of sixth stage*: the pulley tied over the second suture.

The first stage is performed as above. The second stage is omitted, and the surgeon passes on to the third stage, which, together with the fourth, is unaltered.

Fifth Stage.—The needles of the doubly armed suture are passed through the flap from deep to the superficial surface, and then one is made to travel in the same course as that of the pulley suture, which was omitted. The ends are then tied. In this modification the tissues grasped by the pulley suture act as the pulley. They are more liable to cut through and give way than in the original operation; and the modification did not receive any very great encouragement from extended trial.

GROUP 3.—Folding of the muscle without division.

Musculo-capsular advancement.—In the operation generally known under this name, the muscle is not divided, but dragged forward and folded on itself under the conjunctiva. It is supposed that in this way the attachments of the muscle to its sheath and the other fascial structures are preserved intact.

This is not quite the case, since the surface and borders of the muscle are always exposed to some extent. The method of De Wecker (25) may be regarded as typical.

De Wecker's Operation

Instruments.—Speculum, fixation forceps, scissors, squint hook, two stout silk sutures, needles and needle-holder.

First Stage.—The surgeon makes an incision, over the insertion of the muscle to be advanced, with the scissors, and excises an elliptical piece of conjunctiva about one-third of an inch high and about one-fifth of an inch wide, exposing the muscle in its sheath.

Second Stage.—He picks up the muscle on the squint hook and lifts it away from the globe.

Third Stage.—Then taking one of the sutures in a curved needle, he pierces the conjunctiva close to the outer lip of the conjunctival wound, and makes the needle travel through the muscle and sheath from before backwards into the space made by holding the muscle away from the eye. Here it passes beneath the hook, and then again traverses the muscle to emerge in the conjunctival wound. Now the surgeon with a fresh hold

of the needle passes it under the inner lip of the conjunctival wound through the tendon close to its insertion and onward through the episcleral tissue, and finally brings it out close to the sclero-corneal junction, almost in the vertical meridian; he thus obtains a firm anchorage for the suture. The second he passes in the same way.

When they are tied the muscle is folded on itself and practically shortened.

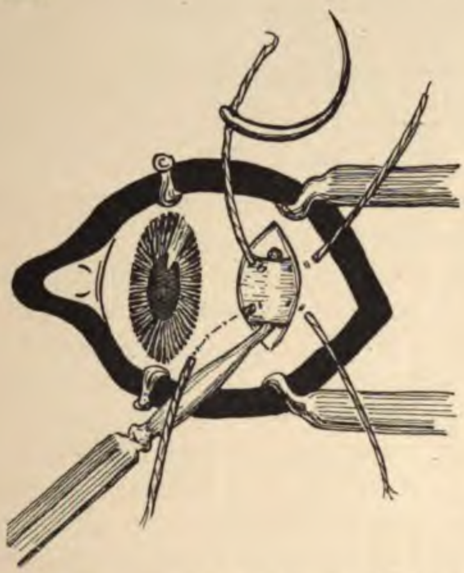

FIG. 24.—De Wecker's operation. The passage of the lower suture is complete, the upper has pierced the muscle only.

Fourth Stage.—Before tying the sutures, the opponent must be tenotomised, if this is thought requisite.

This operation is now very commonly used instead of the usual advancement. If in Williams' operation (described above) the tendon is not divided, the muscle can be advanced in its sheath, and the musculo-capsular advancement made. Koster has recommended a procedure which is, in all essentials, this "modified Williams'" operation.

It is clear that the operation of Jocqs is not in the ordinary sense a musculo-capsular advancement: if it deserves the

name, this must also be given to Critchett's method, as here described.

Trousseau (26) has recently suggested that it may be, in some cases, unnecessary to divide either the conjunctiva or the capsule to obtain an advancement of these structures, but that by means of what he calls a "capsular ligature" the desired effect may be easily obtained.

The operation is performed as follows :—

Trousseau's Operation

Instruments.—Speculum, fixation forceps, scissors, needle and needle-holder.

First Stage.—The surgeon picks up the tendon of the muscle to be advanced in the forceps, grasping it through the conjunctiva, and lifts it away from the globe. Then taking a needle carrying a ligature, he passes it through the conjunctiva near the sclero-corneal junction, through the episcleral tissue, and then through the tendon: after running a certain distance under the muscle, it perforates it and comes to the surface again, through the conjunctiva, near the external canthus.

Second Stage.—A tenotomy of the contracted muscle is performed, and the deep stitch is tied.

A very similar suture has been used by almost all surgeons from the earliest days of the treatment of squint, but the method has not, perhaps, been so carefully studied as it has been by Trousseau.

By one of these methods the surgeon will treat cases of convergent strabismus. In face of divergence, it is rarely of much use to perform a tenotomy; division of the external rectus seldom corrects more than 5° or 7° of deviation, and an advancement of some form will in most cases be found requisite.

Since in divergence it is more common to find good vision in the deviating eye, the correction of the deviation must be as accurate as possible.

Heterophoria

When there is no permanent deviation of the eyes, but only a latent displacement (heterophoria) of small degree, such operations as we have been describing are altogether too drastic for the correction of the defect. In such case the ophthalmic surgeon will usually make trial of prismatic glasses, which relieve the muscular strain. If, after fair trial, these prove inefficient, or if, from any cause, their use is impossible, he must try to improve the position of the muscles; to this end partial tenotomy has been recommended by many surgeons. Prisms cannot often be worn to correct more than 7° or 8° deviation: this will mean a prism of about 7° or 8° deviating angle in each eye, and the glass will be very heavy.

When the latent deviation is convergent and more than 8°, it will be probably necessary to divide the internal rectus of one eye; the simple tenotomy may be performed as described above, care being taken to spare the fascial connections as much as possible.

If the deviation is yet smaller, and glasses cannot be worn, a partial tenotomy may be tried.

Partial Tenotomy (Stevens' method)

Instruments.—Speculum, fixation forceps, small straight strabismus scissors.

First Stage.—The surgeon picks up a small fold of conjunctiva over the middle of the tendon and divides it, making a small vertical incision about 4 mm. long: if the capsule of Tenon has not been divided with the conjunctiva, he divides this by a second incision, laying bare the tendon.

Second Stage.—He picks up with fine forceps the tendon about its middle, and with the scissors makes a button-hole in it, just large enough to admit one of the blades.

Third Stage.—From this button-hole he cautiously divides the tendon upwards and downwards to the required extent,

taking care to work under the conjunctiva without enlarging the wound in it.

Stevens (27), for those cases of heterophoria which cannot be sufficiently corrected by a tenotomy, has suggested a method of advancement more accurate, as he claims, in adjustment than others. It is a modification of Critchett's operation.

Stevens' Operation

Instruments.—Two pairs of locking fixation forceps, scissors, speculum, needles and needle-holder.

First Stage.—The surgeon lays bare the insertion of the muscle to be advanced, and marks the centre of the insertion

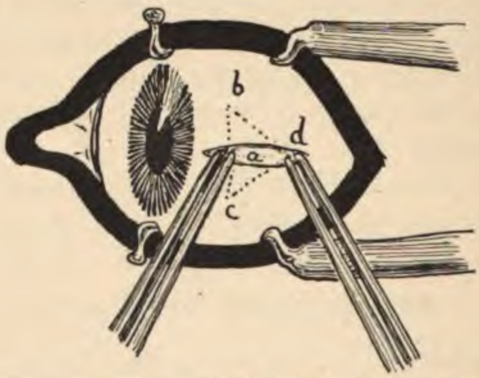

FIG. 25.—Stevens' operation. The dotted triangle bed shows the part of tendon removed.

by a pair of fixation forceps; then he draws the tendon out of the wound until he can fix the second pair of forceps on the centre of the tendon, at a point such that the distance between the forceps is equal to the amount of advancement determined.

Second Stage.—He then tenotomises the muscle, starting from the point of adhesion of the first pair of forceps and cutting up- and downwards. This incision is represented in the diagram by the line *b a c*; from the extremities of the incision he cuts to the point of adhesion of the second forceps, *d* in the diagram,

and excises a triangular section of tendon, the distance *a d* being the amount of advancement required.

Third Stage.—The edges of the cut tendon are then brought together and secured by sutures.

It is clear that only the central part of the tendon is advanced to the extent required, the edges being allowed to retain their old relations. It is not unlikely that the central stitch will give a little.

In the case of latent divergence (exophoria), a simple tenotomy is not likely to give an effect of more than 5° or 6°; if the defect is greater than this, some form of advancement must be undertaken. When the deviation is vertical (hyperphoria), division of the tendon has even less power of correction; a tenotomy of the superior rectus allows a downward rotation of 2° or 3° generally, and a division of the opposite inferior rectus has a little more effect in adjustment. Should there be any great vertical displacement, advancement is the only means of correction. In the smaller forms prisms are usually better able to give relief, and are more accurately adaptable.

Paralytic Squint

The deviation following paralysis of a muscle may be temporary or permanent: no operation would in any case be undertaken for temporary paralysis. If one lateral rectus be paralysed, it may recover power, and yet the eye may have a permanent deviation from contraction of the opponent. Under these circumstances the surgeon will deal with the case as if it were a concomitant deviation.

If there remain permanent paresis and diplopia except in a certain position of the head and eyes, it may be desirable to put the eye into a more convenient situation, and thus relieve the uncomfortable strain which the attitude entails. It will usually be found that an advancement is preferable to a tenotomy of the opponent, though it may be necessary to combine the two.

If there be permanent paralysis of one muscle, the surgeon

cannot hope to rid the patient entirely of his diplopia; if any operation be undertaken, it will be almost entirely for cosmetic reasons, and the patient should be warned that the resulting improvement in appearance is likely to be only temporary. In such a case, again, the surgeon will make a large advancement of the paralysed muscle combined with a free tenotomy of the opponent. Under certain circumstances it might be permissible, if this operation did not satisfy the patient, to make the remaining lateral rectus inactive by dividing the muscular belly behind the attachment of the lateral elastic ligament.

This operation is practically the original method of Dieffenbach for concomitant squint, which, as we have already pointed out, was given up because the muscle often lost all power. This result, so undesirable in concomitant squint, is what we strive for in dealing with the opponent of a permanently paralysed muscle.

If all power of movement be permanently lost, the eyes may be fixed in such a position as to occasion permanent diplopia; here the surgeon may be called upon to undertake measures adapted to altering the static position of the eye, by tenotomy or advancement, or by a combination of these operations.

Paralysis of one of the vertical recti, or of an oblique muscle, is much more difficult to relieve, and the last has been for the most part regarded as irremediable by operation. Recently there appeared a paper by Dr Edward Jackson (28), suggesting that it would be possible to overcome the disturbance due to paresis of the superior oblique, at least to some extent, by operation on the superior rectus.

The explanation of the proposal is as follows:—

The superior oblique has a somewhat complicated action on the cornea, as we have already pointed out; its functions are "intorsion" of the cornea and movement downward and outward. Should this muscle be paralysed, its functions will be taken over, in part at least, by other muscles. The downward rotation will be effected by the inferior rectus, the outward by the external and the intorsion by the superior rectus. At the same

time there will be active inhibition of its opponents, which will also assist in carrying out the required movement. Thus inhibition of the inferior oblique will counteract the tendency to extorsion, inhibition of the internus will make external rotation easier. The downward rotation will be facilitated by inhibition of the superior rectus. Unfortunately the plan of compensation requires that the superior rectus should be inhibited for one action, and should act more strongly than usual for another.

The inferior rectus, acting alone in the circumstances we have imagined, with more powerful effort produces more "extorsion" than normal. The chief factor of the action of the superior rectus, in view of this, is the power to restrain extorsion, the power of elevation being even harmful. We must, then, seek to increase the power of "intorsion" and diminish the power of elevation and inward rotation. All these indications are met when we displace the attachment of the tendon outwards and backwards. The backward displacement acts like a tenotomy to diminish the power of the muscle in elevation, and the outward displacement is practically an advancement to increase the "intorsional" power.

FIG. 26.—Jackson's operation. Insertion of rectus superior. The dotted line shows the required position.

It is a matter of great importance to proportion the displacement of the insertion to the requirements of the case in hand: Dr Jackson reminds us that in all cases the adjustment is only approximate, but that if we give nature any encouragement, she will make good any remaining defect. Since the globe is about a sphere of 12 mm. radius, 1 mm. on the surface of the globe corresponds to about 5° of deviation. Remembering this relation, the surgeon can obtain very close adjustments. Dr Jackson's cases, quoted in the paper, prove this fully.

Jackson's Operation

Instruments.—Speculum, fixation forceps, scissors, squint hook, half-curved needles and needle-holder.

First Stage.—The surgeon seizes the conjunctiva with the forceps over the outer edge of the superior rectus, raising an antero-posterior fold, and divides it about 8 mm. behind the cornea, rather obliquely backwards and outwards, so that an incision about 10 mm. long is made; the inner end of this incision should lie over the junction of the inner and middle thirds of the tendon, and the outer end should lie some 3 or 4

FIG. 27.—Jackson's operation. *Second stage*: The passage of the suture is complete.

FIG. 28.—Jackson's operation. The muscle attached to the new insertion.

mm. outside the tendon. The tendon is dissected a little from its connections, lifted on a squint hook and brought to sight.

Second Stage.—The surgeon now takes the needle and passes it through the tendon about 1 mm. behind its insertion, at the junction of the inner and middle thirds. He then carries it under the tendon to the temporal edge; then lifting the posterior lip of the conjunctival wound he makes the needle travel in the sclerotic, entering it at a chosen point, about 5 mm. behind and external to the point of passage through the

tendon. The extent of traverse of the sclerotic should be some two or three millimetres, and the point of exit should lie rather behind the point of entrance: it is, of course, important to gain a firm hold without perforating the sclerotic. Finally the needle is brought again under the tendon and made to perforate it at about the junction of the middle and outer thirds from the lower to the upper surface.

Third Stage.—The tendon is divided at its insertion, care being taken to avoid cutting the suture, and this is tied, fixing the tendon in its new position.

Landolt, for similar paralyses, especially for those resulting from disturbance of the pulley of the superior oblique in operations on the frontal sinus, advances the inferior rectus, and is said to gain good success.

The last indication for operation on the ocular muscles was said to be enophthalmos. This usually arises as a substitute for excision, and the matter will be dealt with fully under this head.

The operations of Motais and Parinaud, in which the superior rectus is called upon to replace the levator palpebræ superioris, will be dealt with under the head of ptosis in the next chapter.

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CHAPTER II

OPERATIONS FOR PTOSIS

PTOSIS—drooping of the upper lid—is a condition which may require surgical interference. It occurs as a congenital malformation due to want of development of the levator palpebræ superioris, or as an acquired condition following paralysis or paresis of this muscle; slight degrees of ptosis not calling for treatment result from long-standing blepharospasm, or from swelling of the upper lid, whose weight may overtask the power of the levator.

Although the lid is raised chiefly by this muscle, yet when we wish to open the eye very wide we naturally throw into action the frontalis. This tightens and draws up the skin over the eyebrows, and hence indirectly the skin of the lids. If the levator is paralysed, this accessory muscle is the only one which we can call into action, and the frontalis was the first aid which surgeons sought to remedy the defect.

On the other hand, the accessory muscle has none of that intimate association with the elevators of the globe which causes the movements of the two structures to have so close a relation with each other.

This fact has therefore led some surgeons, when the levator is paralysed, to seek to use the only other muscle possible, viz., the superior rectus.

A short anatomical sketch of the structures involved in the various operations for ptosis is necessary for their understanding.

The upper lid is a fold made up of several layers covering the upper part of the globe. The skin is continuous with the skin of the brow, but is much thinner and more lissom. It has little and very loose subcutaneous tissue, and the hairs are reduced to fine down. Under the skin is found the orbicularis palpebrarum, a fairly well-defined circular muscle, which, however, sends fibres into the various other superficial muscles in the neighbourhood; thus it is connected with the frontalis, the zygomatics, and others. It overlies the tarsal plate, and is attached firmly to the inner and outer tendines oculi. The tarsal plate is a dense fibrous mass, of a semicircular shape, forming the real skeleton of the lid, continuous above with the firm orbital fascia, and through this attached to the superior border of the bony orbit; the junctions of the superior and inferior tarsi form the tendines oculi, which have been alluded to already. The posterior surface of the tarsus is lined by the adherent conjunctiva.

The muscles concerned in lifting the lid are three, of which one, the levator palpebræ, is the most important. This arises close to the rectus superior at the apex of the orbit, and, passing forward, sends off about the equator of the globe a strong offset of its sheath to join the fascial funnel. At the same level the muscle receives a strong band from the underlying rectus and the tendon divides: the chief part is inserted directly into the upper border of the tarsus, but accessory bands go into the fold of the conjunctiva and to the skin; this last band consists very largely of unstriped muscle. By this insertion the levator draws on all the structures of the lid at once. The action of the frontalis is less direct; this muscle raises the brows and thus puts the skin of the region on the stretch; in this way it is able to assist in opening the lid when a strong effort is made, but it can be seen at once that the action is very imperfect.

The rectus superior has even less action, its power being limited to the band which was mentioned above as running from the rectus to the levator tendon.

It will be realised at once that, if the levator is absent

or paralysed, the movement of the lid is seriously impaired. Operations for the relief of this condition have as their object a better connection between the accessory muscles and the lid.

It has been pointed out in the opening words of this chapter that the forms of ptosis are multiple; the method of dealing with them will vary with the form.

It is most important to assure oneself of the presence or absence of the levator palpebræ as an active agent. When this muscle is merely weak, it is often possible to assist it by altering its insertion in such a way that it is able to act at better advantage. If, on the other hand, the muscle be entirely inactive, either from congenital or acquired defect, such a procedure is inapplicable. It becomes, therefore, a matter of supreme importance to diagnose the form of ptosis correctly. This is usually not difficult to do; the history will often be of assistance; congenital varieties are most frequently found with little or no power of the muscle. Acquired ptosis, except of very small degree, is usually due to paralysis of the levator, and is usually accompanied by some loss of power of the other muscles supplied by the third cranial nerve.

If the surgeon is in doubt as to the power of the levator, he places himself in front of the patient and depresses the eyebrow on the affected side firmly; he then asks the patient to open the eye. Any movement of the lid must be occasioned by the levator, since the depression of the brow puts it out of the power of the frontalis to raise the lid at all.

In congenital ptosis, when there is no action of the levator the muscle is often entirely absent, and the superior rectus may be absent also. In paralysis, even of long standing, the tendon of the levator will be still recognisable, and may be used, as in Sourdille's operation, as a point of attachment for the frontalis. So long as there is any prospect of improvement of the paralysis there will be no question of operation, and even when the loss of power seems definite, attempts may be made to raise the lids mechanically by means of a spring attached to spectacle frames, before any operation is undertaken.

When the ptosis depends on increased weight of the lid, appropriate treatment, by astringents, etc., will often do all that is necessary.

The earliest method of operation for ptosis was to shorten the lid so much that the pupil would be exposed and vision be possible under the raised margin. The skin of the lid was excised to a large extent; when, however, the lid was shortened enough to allow vision under it, the palpebral fissure remained permanently open, and the cornea was exposed to all sorts and degrees of injury. The procedure, as a routine method of treating all forms of ptosis, was soon allowed to drop into well-deserved oblivion.

The first important improvement in the method of operating was due to Bowman (1). He suggested shortening of the levator tendon. It is, of course, necessary that there is a tendon to shorten, and, therefore, this and all other similar methods are inapplicable to cases of absence. The method consists in laying bare the tendon, and either excising a piece or folding it on itself.

Another operation, which Bowman suggested, was shortening of the tarsal cartilage, by excision of a strip; this is, in effect, the same method as the last, since the tarsal plate may be regarded as the direct continuation of the tendon. These procedures have been modified by others, but are still useful when we have to deal with a weakened levator muscle.

When the muscle is entirely inactive it is necessary to call in the aid of the accessory muscles to raise the lid; the first and most obvious course was to increase the attachment of the frontalis to the lid. This has been done in several ways: by the making of an artificial tendon between the frontalis and the deep tissues of the lid, either of scar tissue (Pagenstecher) or of gold wire (Mules). This is a simple and efficacious operation. By attaching the skin to the frontalis (Panas, Hess); these operations are more severe than that of Mules require longer convalescence, and leave more scar. By bringing down a strip of frontalis and stitching it into the lid

(Fergus); we have no personal experience of this method, which seems efficient. By dissecting out the tendon of the levator and attaching it to the frontalis (Sourdille, Angelucci); this regularises the pull of the frontalis, which, in Panas' operation, is exerted too much on the skin of the lid, and thus tends to produce ectropion.

This last operation is only possible when there is a well-marked tendon. In all these procedures, in which the frontalis is used, the result is not æsthetically perfect, however good be the union between the lid and the muscle; there is no connection between the movements of the eye and the frontalis; even though the height of the lid be accurately adjusted in the mid position, the relation will be lost when the patient looks up or down, owing to the want of co-ordination between the motions.

For this reason other surgeons (Motais, Parinaud) have sought to make use of the superior rectus muscle, and to connect this with the lid. The movements of the lid and eye are thus brought almost into their normal relation. The lid moves up and down with the eye.

Since, however, the superior rectus is called upon to undertake a double duty, the upward rotation of the globe is less than usual; hence there will be diplopia if the other eye have normal movement. Motais' operation, then, is applicable only to those patients who have double ptosis.

We have already drawn attention to the fact that the superior rectus is sometimes deficient in these cases, either from defect of the development of the whole muscular sheet, or from want of use (it is clear that such a patient will never voluntarily rotate his globe upwards, since this lifts the pupil entirely under the lid); Motais' operation demands an active superior rectus, and is clearly unsuitable for all cases where this muscle is even slightly weakened. Another defect is that the eye remains open during sleep, and the cornea is therefore exposed to attacks of keratitis. There has been, on this account, a reversion towards the older forms of operation.

Operations for Ptosis

Group 1.—Shortening of lid or levator.

(*a*) Excision of skin.

(*b*) Excision of parts of tendon and tarsus (method of Bowman).

(*c*) Folding of tendon (method of De Lapersonne, Everbusch).

(*d*) Excision of tarsus.

Group 2.—Utilising the action of the frontalis muscle.

(*a*) By artificial tendon (method of Pagenstecher, Mules).

(*b*) Altering the relation of the skin (method of Panas, Hess).

(*c*) Attaching strip of frontalis to the lid (method of Fergus).

(*d*) Attaching the tendon of the levator to the frontalis (method of Sourdille).

Group 3.—Utilising the action of the rectus superior (method of Motais, Parinaud).

Group 1 (*a*).—The earliest method of treating ptosis by operation, the excision of a large piece of the skin of the lid, is now never used. When the lid was sufficiently raised by such excision to allow vision under the previously drooping margin, the cornea was permanently exposed and inflammation frequently followed.

The procedure is therefore of only historical interest, and needs no detailed exposition.

Group 1 (*b*).—The next method, due to the genius of Bowman, was shortening of the levator tendon. This is of great value when the levator is present but weak.

Bowman's (1) Operation by shortening the Levator Tendon

Instruments.—Scalpel, fixation forceps, scissors, needles and needle-holder.

First Stage.—The upper lid is everted, exposing the convex border of the tarsal plate. The surgeon makes, with the scalpel, an incision through the conjunctiva only, along the whole length of the tarsus, close to the convex border. From this he dissects the conjunctiva back, laying bare the tendon of the levator, which is inserted by its chief part into the upper edge of the cartilage.

Second Stage.—Holding the tendon well in view, he passes two or three sutures through it, about half an inch from the tarsus.

Third Stage.—He then divides the tendon in front of the sutures and excises the part intervening between the second incision and the tarsal plate, together with the extreme upper border of the latter.

Fourth Stage.—He then brings the cut edges together by means of the sutures which were placed in the tendon before division.

Group 1 (*c*).—Snellen (2) has suggested that it would be possible to omit the incisions, and pass sutures in such a way that when they were tied they would double the tendon on itself.

First Stage.—The surgeon passes, from the cutaneous surface, a suture through all the tissues of the lid at a level just above the tarsal plate.

Second Stage.—Then everting the lid he passes the needle through the conjunctiva and through the underlying tendón as high as possible: the ends emerge on the skin at a little distance from one another, and are tied firmly over a roll of plaster or a piece of drainage tube. Three such sutures are necessary.

Everbusch (3) has modified the original suggestion of Sir William Bowman in the following way.

Everbusch's Operation

Instruments.—Snellen's clamp, scalpel, dissecting forceps, needles and needle-holder.

First Stage.—The surgeon inserts Snellen's clamp, pushing it up into the superior cul-de-sac as far as possible. Then he makes an incision through skin and orbicularis, in the whole

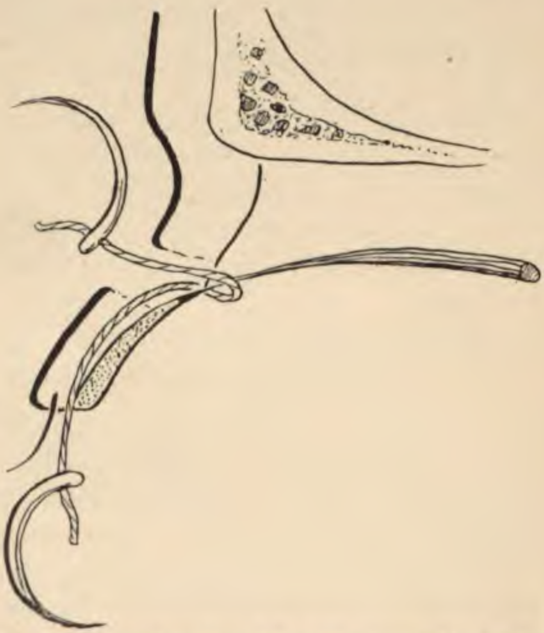


FIG. 29.—Diagrammatic section of the parts concerned in Everbusch's operation. *Middle of second stage.*

length of the lid, at a line midway between the lashes and the eyebrow. He dissects up the lips of this wound so as to expose the tendon of the levator and the tarsal plate.

Second Stage.—He then takes a suture armed at each end with a needle, and passes it through the exposed insertion of the muscle, and after a short passage on its posterior surface, of some 2 or 3 mm., brings it again on to the exposed surface; the

two ends of the suture, each with its own needle, lie on the anterior surface of the tendon, and the loop lies on the posterior surface, just beneath the conjunctiva. Now he takes each needle in succession, and carries it downwards in the cellular space between the orbicularis palpebrarum muscle and the tarsal cartilage to the free margin of the lid, where they emerge at the grey line. Three such sutures are passed, one at the centre

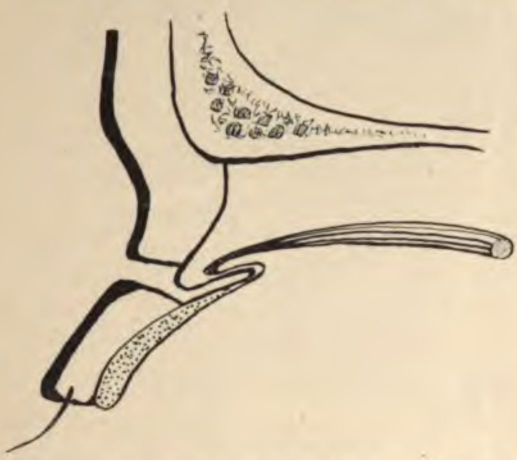


FIG. 30.—Everbusch's operation. Folding of tendon produced by sutures.

and one near each side of the tendon. When they are tied the tendon is doubled on itself and brought on to the anterior surface of the tarsus.

Very similar is the idea of De Lapersonne's (4) plan.

De Lapersonne's Operation

Instruments.—Horn or metal spatula, scalpel, dissecting forceps, squint hook, needles and needle-holder.

First Stage.—The surgeon makes an incision about 4 or 5 mm. above the free border of the lid, in its whole length, through skin and orbicularis. By slight dissection he lays bare the tarsal cartilage, its suspensory ligament, and the insertion of the levator palpebræ.

Second Stage.—From the upper border of the cartilage, at each side of this tendon, he makes a small vertical incision

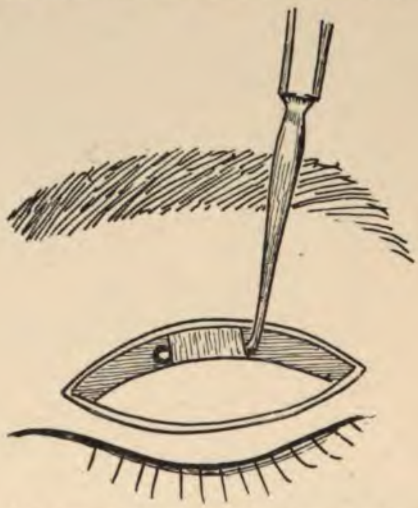


FIG. 31.—De Lapersonne's operation. Exposure of levator tendon.

through the suspensory ligament (the orbital fascia); through these he is able to pass the squint hook under the tendon.

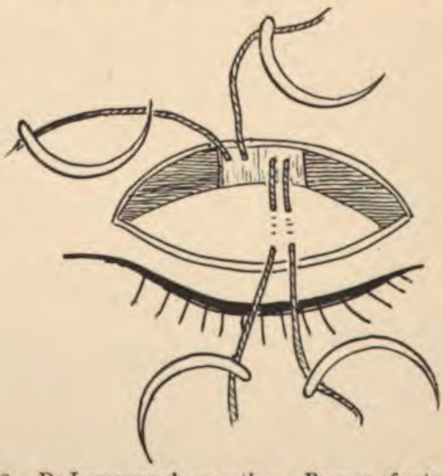


FIG. 32.—De Lapersonne's operation. Passage of sutures.

Third Stage.—The surgeon now takes one of the sutures and passes it twice through the tendon at some distance above the

hook: the point of passage will vary with the effect desired, being further back as the defect is greater: in this way, the points of entrance and exit being about 2 mm. apart, a small loop is made on the posterior surface of the tendon and both ends of the suture are on the anterior surface. Then the needle is made to perforate the substance of the tarsus on its anterior surface, and, after a short passage in this tissue, to reappear on the anterior surface.

A second suture is passed in a similar path on the other side of the tendon. When both have been inserted, the surgeon proceeds to the *Fourth Stage.* The muscle is cut through close to its insertion into the tarsus, and, if necessary, a piece is resected. When the sutures are tied the tendon is reattached to the anterior surface of the tarsal plate, where it can act at better advantage.

If the drooping be not entirely overcome (*Fifth Stage*) a small strip of the skin and orbicularis must be removed from the lid and the wound closed by several sutures.

Wolff's Operation

Wolff (5) advances the levator either from the skin surface or from the conjunctival. His method involves division of the muscle; it is somewhat complicated and seems to have few advantages over those here described.

Group 1 (*d*).—In another case Bowman excised the greater part of the tarsal cartilage and reunited the fragments. This method was revived by Gillet de Grandmont (6), and has been called after his name.

The description of Bowman's operation, which is to be found in the first volume of the Moorfields' Reports, is very imperfect, but suffices to show that in idea the two methods are identical, though perhaps differing in detail. The idea is almost the same as that of his previous method, since the tarsal cartilage may be regarded as the direct continuation of the tendon.

Grandmont's Operation (Bowman's Second Method)

The same instruments are required.

First Stage.—The surgeon inserts Snellen's clamp and makes an incision in the skin of the lid about 3 or 4 mm. above the free margin and parallel to it; the incision should be about an inch in length.

Second Stage.—He then dissects up the skin on each side of the wound, exposing the surface of part of the orbicularis muscle: this he excises, so that the underlying tarsal plate is laid bare almost in its entirety.

Third Stage.—He then makes an incision through the tarsal cartilage from side to side about 4 mm. from the free border, and above this another curved with the concavity downward, touching the first at either end and including in the space thus outlined the greater part of the tarsus. This is now removed.

Fourth Stage.—The two parts of the cartilage are brought together by several points of suture. It is not usually necessary to put any in the skin wound.

Gruening's method is similar; both these amount to advancement of the levator.

GROUP 2 (*a*).—Attachment by artificial tendon.

The first method, that of Pagenstecher, consists in passing two or more silk threads down from the forehead through the lower part of the frontalis muscle and thence subcutaneously almost to the lower border of the upper lid. Here they are made to emerge. The threads are left in until pretty free suppuration is excited all along their course. It is hoped that bands of new connective tissue will form along these sinuses, and permanently connect the lid with the muscle. This is a very rough and unsatisfactory expedient.

Mules' (7) method may be regarded as in some sense a modification of this.

Mules' Operation

First Stage.—He commences by making a small incision in the margin of the lid about its middle, some 5 or 6 mm. long and about 3 mm. deep. This incision is made rather behind the "grey line," which indicates the plane of connective tissue between the lashes and the tarsal cartilage, and thus invades the latter somewhat. Just above the brow a single puncture is made with the point of a scalpel opposite the middle of the marginal incision.

Second Stage.—Now a special needle, with its eye near the point, is passed from above downwards, entering at the puncture above the eyebrow, passing through the lower fibres of the frontalis, and emerging at one end of the marginal incision. It is now threaded with very fine gold wire and withdrawn, carrying the wire up to the puncture. The skin of the eyebrow is now pushed over towards the other end of the marginal incision, and the needle, again unthreaded, is introduced a second time at the puncture and made to come out at the unoccupied end of the marginal wound. Here it is threaded with the other end of the gold wire and withdrawn. We have now a loop of gold wire embedded in the tarsal cartilage near the lid margin, the two ends passing out through the frontalis. The lid can be drawn up to any required extent by tension on these ends; they must then be twisted together to form a continuous loop, attaching the frontalis to the tarsal cartilage. A little care is needed for this. The ends must be drawn a few millimetres

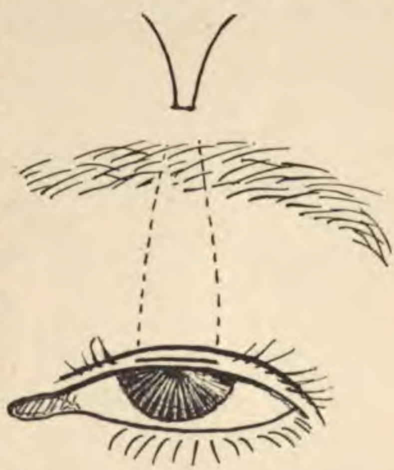


FIG. 33.—Mules' operation. The dotted line shows track of wire.

further out of the wound, a probe laid on the skin, and the wires twisted round each other over this; then the twist is cut short, and, after withdrawal of the probe, pressed down into the puncture. The two little wounds may be closed, if necessary, by sutures.

The gold wire, which gives rise to no irritation, acts as a permanent artificial tendon.

The advantages of the method are its simplicity, the absence of scar, and the short time of convalescence. Its disadvantages are the possibility of the twist slipping, and some slight tenderness—which persists for a long time—over the gold loop.

Those patients on whom we have done the operation have been extremely pleased with the results.

Several points have been urged against this operation; it has been objected that the metallic foreign body is not likely to remain permanently in place, in a part so constantly in motion as the lid, and that the wire is apt to work out after some time. We have never known the wire extruded, although we have been able to watch patients after the operation for several years; one case was under observation for five years, and in this time nothing happened to impair the original satisfactory result.

The twist is not always sufficiently firm; on one occasion the hold slipped after about forty-eight hours. It was necessary to search for the wire, withdraw it, and replace it by another length. Fortunately there was no difficulty in this proceeding; the accident was the result of inexperience, and not attributable to any fault of the method.

If the twist of wire is not well bent down and buried, it may perhaps work to the surface; this, again, is rather a reflection on the operator than on the operation.

It has further been objected that the incision in the lid margin leads to inversion of the lashes and trichiasis. This has not been our experience; on the other hand, if the suture be placed merely subcutaneously and not buried in the marginal tissues, the hold between the frontalis and the lid is much weakened.

Lastly, it is said that the lid cannot be everted after this operation without risk of breaking the wire; this objection is purely theoretical; no case of such accident is recorded, and, in view of the great flexibility of the wire, it is most unlikely.

To combat these points, two modifications have recently been suggested by Worth (8) and by Harman (9).

The former uses specially prepared kangaroo tendon for the suture, and does away with the necessity for a knot by a somewhat complicated and lengthy passage. The tendon is split and scraped with a knife to make it thin and smooth; it is soaked in ether to remove grease, and afterwards in a solution of biniodide of mercury; finally it is lubricated with sterilised vaseline.

Each end is armed with a Hagedorn's needle.

Worth's Operation

The field of operation is prepared, the eyebrow shaved, and the skin carefully washed. A general anæsthetic is necessary.

Instruments.—The armed suture, needle-holder, scalpel, scissors and horn spatula.

First Stage.—Two small incisions are made in the grey line of the margin, one on each side of the middle line of the lid; each is about a sixth of an inch long and about the same distance from the fellow. A third small incision—a mere puncture—is made about half an inch above the brow opposite the middle of the lid.

Second Stage.—One of the needles is introduced at the central end of one of the incisions in the lid margin (B in the diagram) and carried upward subcutaneously, until it emerges at the central puncture above the brow; here it is re-entered and carried downwards to the central end of the other incision (C in the diagram). There is now a subcutaneous loop of tendon with the two ends emerging at the marginal incisions; each needle in turn is entered at the other end of the corresponding incision and again carried upward in the subcutaneous tissue above the

brow, and made to emerge at a point on each side of the central loop (U, X, in the diagram). By drawing on the suture at B and C, the loop V is sunk into the tissues: the loops at the marginal incisions are then drawn in and buried by traction on the ends at U and X, and the lid is raised by this traction to the required extent. Finally the needles are reintroduced at U, X, and driven subcutaneously across to the opposite sides of the brow, emerging at Z and Y respectively; the ends are cut short, and buried by slight traction on the skin.

This method leaves no scar, and, therefore, the cosmetic result is good immediately, but the shaving of the eyebrow involves a deformity lasting some weeks or even months; for a patient dependent on his appearance the method is not so good as that of Mules.

Harman's Operation

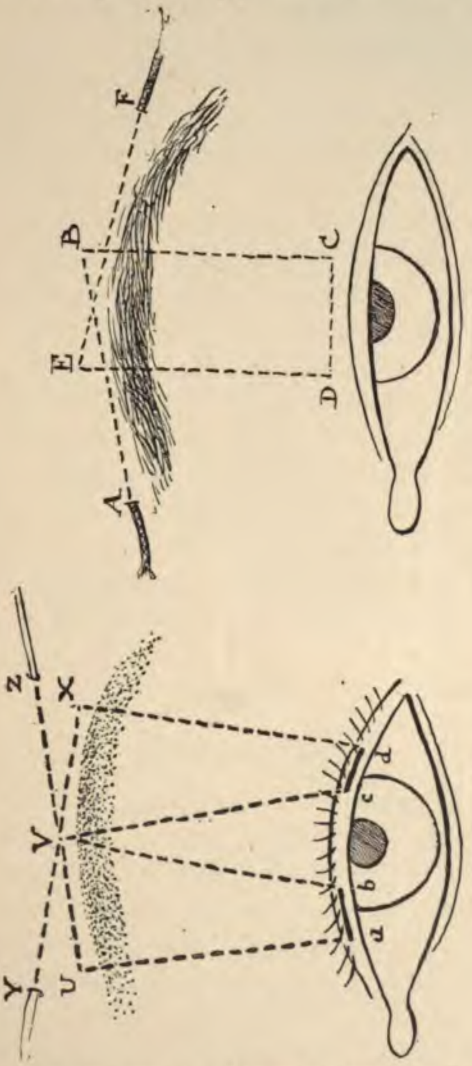
About the same time, Bishop Harman suggested another and in some respects superior modification. He points out that the kangaroo tendon is difficult to prepare, and draws attention to the statement of Worth that he was not sure of its stability in the tissues.

Harman uses a fine chain of the variety known as "wove chain," made of very fine wire, quite smooth to the touch, and weighing only two grains to the inch.

He adopts yet another path for the suture; the essential difference is that he avoids splitting the lid margin, by burying the chain subcutaneously just above the roots of the lashes. In this way he gets over the risk of the inversion which he says may follow Mules' original procedure. The course of the suture can be seen easily from the diagram. The instruments required are the chain and a needle of the usual bayonet shape. The chain may be soldered to the needle or secured to it by a piece of silk.

The needle is introduced through the skin above the inner end of the brow and carried deeply upwards and outwards to a point (B in the diagram) just external to the centre of the brow:

a length of chain is drawn through, sufficient for the rest of the passage; about six inches are enough. The needle is then re-inserted at B and passed deeply beneath the tissues of the fore-



Harman's operation.

Worth's operation.

Fig. 34.—Modifications of Mules' operation.

head vertically downward in the subcutaneous plane of the lid to a point (C in the diagram) near the lid margin.

Reinserted at C, it is passed through the tarsus to a point D

on the skin of the lid. Hence it passes vertically upwards to a point E above the eyebrow, and finally being reintroduced at E, it is carried to F just above the external angle of the brow.

The surgeon now raises the lid to the required extent by traction on the exposed ends, and when this adjustment has been made, cuts off the chain and buries the ends under the skin.

The parts of the chain buried under the skin prevent the lid from drooping until the granulation tissue has grown up into the spaces.

Harman recommends that the final adjustment of the height of the lid should be made some days after the primary operation, and that the ends of the chain be left long for this period, so as to allow of such adjustment.

This method is but little more difficult than Mules' plan; the avoidance of the marginal incision is—considering the thickness of the suture employed—an improvement. One great drawback to the modification is that the chain is necessarily drawn over considerable tracts of skin during its prolonged passage, and unless aseptic preparations have been very complete, there is a risk that it may be infected during this either from the skin itself or from the hairs of the brow, which are not shaved.

GROUP 2 (*b*).

Panas' Operation

In Panas' (10) operation a fold of the skin is carried upwards and fixed to the frontalis muscle.

Instruments.—Scalpel, dissecting forceps, horn spatula, scissors, squint hook, pressure forceps, needles and needle-holder.

Of these the horn spatula and the squint hook may be omitted, but the latter is very useful in holding parts out of the surgeon's way.

General anæthesia is required, and the eyebrow must be shaved.

First Stage.—Stretching the eyelid over the horn spatula, he makes an almost horizontal incision in the normal fold of the

lid, just below the brow, through skin and orbicularis, so as to lay bare the orbital fascia.

A second incision parallel with this is made through the skin and muscle along the eyebrow, and the bridge thus made is freed from its deep attachments and remains fixed only at its extremities.

The width of the bridge is the measure of the height to which

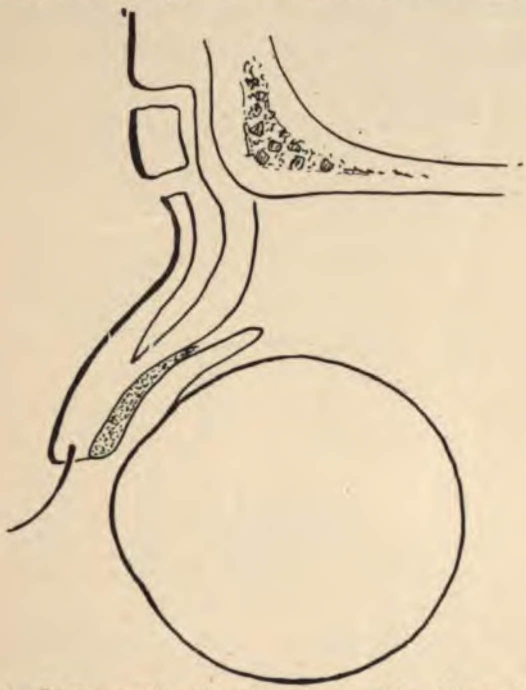


FIG. 35.—Diagrammatic section through upper lid and brow, showing parts concerned in Panas' operation.

the lid will be raised by the operation. It must therefore be accurately estimated before the second incision is made. From the lower wound two vertical cuts are made down to a point below the upper margin of the tarsal cartilage; hence they diverge almost horizontally. The central flap thus marked out is dissected up, and left attached only by its lower part.

Second Stage.—The surgeon now takes a needle threaded with thin strong silk, and passes it through the skin and muscle

above the highest incision, opposite one edge of the central flap. Next, holding the bridge out of the way (and this may be done most conveniently with the squint hook), he passes the suture underneath it to the central flap, which is in turn perforated at one corner; then he brings the suture back under the bridge and through muscle and skin to a point close to the point of entrance. A second suture is passed in the same way, holding the other corner of the central flap. If now the four threads be drawn upon, this square of skin will be drawn up through a

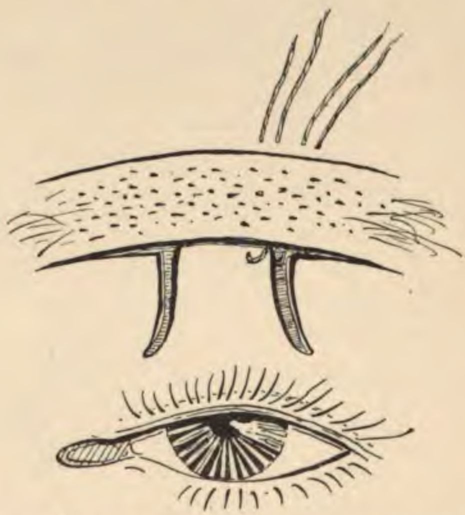


FIG. 36.—Panas' operation. Sutures on the left side only.

distance corresponding to the height of the bridge, and fixed closely to the frontalis. It will often be found that there is some little eversion of the lid, and to correct this it is often necessary to pass other sutures to draw up the tarsal plate before the first are tied.

Taking a similar suture to those already used, the surgeon passes it through the skin and muscle nearer the canthus than the principal ones already passed, under the bridge, and, at the outer side of the "tendon" flap, takes hold, with the suture, of the orbital fascia and upper edge of the tarsal cartilage; then

passes the suture under the bridge and through muscle and skin to the surface. One such is passed on each side. These, by drawing up the skeleton of the lid, prevent eversion.

Third Stage.—All four are tied over a piece of drainage tube, and the wounds closed, as far as possible, with several stitches.

There are several points of disadvantage in this operation.

FIG. 37.—Panas' operation. Position of parts after sutures are tied.

It will be noticed that the deep surface of the bridge lies in contact with skin, and can only be covered from its edges by growth of cells. This entails a comparatively long convalescence and a permanent dimpled scar, which, however, is much less noticeable than would be naturally expected.

On the other hand, the connection of skin and muscle is close, and the possible action is the maximum. The elevation can be gauged with great accuracy, and the operation, though its

description may read slightly complex, is, as a matter of fact, very simple.

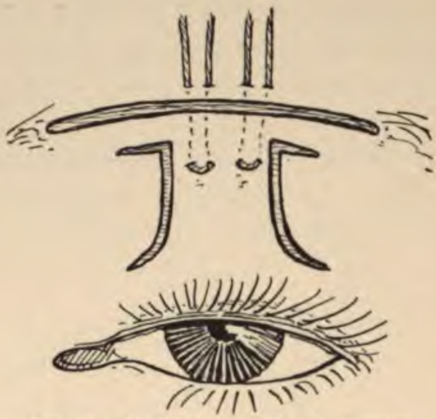


FIG. 38.—Modification of Panas' operation.

A slight alteration of the incision will allow the surgeon to avoid the objectionable coaptation of skin to a granulating

FIG. 39.—Diagrammatic section of parts in modified Panas' operation.

surface which was mentioned as the chief disadvantage of this operation.

First Stage.—Having decided the amount of elevation desired —*e.g.* 6 mm.—and having made the first incision in the usual way, the surgeon makes, at a distance equal to 3 mm. below the first, two others, separated by a space about 10 mm.; from the proximate edges of these, two vertical incisions are carried downwards for about 12 mm., and then turned slightly towards the inner and outer extremities of the lid.

The whole area marked out by these incisions is then dissected up; two stout sutures armed at each end with a needle are passed through the skin at a distance of 6 mm. from the first incision at the point shown in the diagram, and then onward, under the loosened skin, to the first incision; here they sink deeply through the frontalis, to emerge above the brow. When they are drawn tight, the fold of skin is drawn up under the eyebrow to gain attachment to the frontalis. It may be said that the attachment of the skin is not so close as that in the original operation, since the dermis is not divided: this objection can be met by making an incision across the tendon flap 6 mm. from the top, and passing the sutures as in Panas' method, but taking a hold on the upper part also of the tendon flap.

An operation with a somewhat similar design is that of Hess (11).

Hess' Operation

The instruments needed are a scalpel, dissecting forceps, needles and needle-holder; to these a horn spatula and one or more pairs of Spencer Wells pressure forceps may be added as of possible utility.

First Stage.—The patient being anæsthetised, and the eyebrow on the affected side shaved, the surgeon makes an incision about two inches long through the skin only, in the line of the eyebrow, and dissects down subcutaneously almost to the free border of the lid in its whole length.

Second Stage.—Three sutures are needed, one for the middle and one for each end of the lid. They are armed at each end

with a needle. One needle is passed through the skin close to the fissural margin of the lid and carried upwards, in the interval made by the previous dissection between skin and orbicularis, to the first incision ; here the needle is made to penetrate the muscle deeply, and then brought out through the skin a few millimetres above the brow. The fellow needle is made to penetrate about 5 mm. from the entrance of the first, close to the lashes, and to run a parallel course to its exit. Similarly the two remaining sutures are passed. If, now, the free ends are drawn upon, the lid is raised, and the skin, folded on itself, in the position of the normal fold, is drawn up and makes a new adhesion to the muscle higher than before The sutures, drawn up as high as is necessary, may be tied over drainage tube. The wound is closed separately.

This operation is very simple and requires few instruments. The scarring is imperceptible, being covered by the growth of hair in the eyebrow. The attachment of the skin to muscle is not so close as in the operation of Panas, and the frontalis, therefore, does not act under such favourable conditions as in the former case.

This point might be secured if the first incision was carried through the muscle as well as the skin, and the superficial layer be made by the dissection to include in its upper part some of the fronto-orbicularis.

GROUP 2 (*c*).—Fergus (12) recommends bringing a slip of the frontalis down and embedding it in the lid, on the front of the tarsal plate.

Fergus's Operation

First Stage.—The same instruments are needed. The surgeon makes an incision in the brow, about an inch and a half long; he dissects upwards, so as to lay bare the surface of the frontalis for some two inches and downwards between the orbicularis and the tarsal plate, almost to the lid margin.

Second Stage.—He dissects up, opposite the centre of the

incision, a flap of the frontalis, about three-quarters of an inch broad, separating it on each side from the mass of the muscle for some two inches, and dividing it below, so that it is only attached by its upper posterior extremity.

Third Stage.—Two loops of suture are passed through the muscle flap, and the four needles, after traversing the tarsal plate in its thickness, are brought out on the skin near the lid margin. Here they are tied over a piece of drainage tube.

Fourth Stage.—The skin wound is sewn up. This operation is not difficult to perform on the cadaver, and seems satisfactory, with the exception of obliterating the normal fold of the lid, but we have never had an opportunity of seeing a patient on whom it had been performed. In the original paper an illustration depicts a very successful result.

GROUP 2 (*d*).—Another plan is to attach the tendon of the levator palpebræ superioris directly to the frontalis, so that, when this latter muscle acts, it draws on the normal mechanism for raising the lid. There are two varieties of this method, described by Angelucci (13) and Sourdille respectively.

Angelucci's Operation

Instruments.—Scalpel, dissecting forceps, squint hook, scissors, two sutures armed with needles at each end, needle-holder.

First Stage.—The surgeon makes a curved incision about an inch long a little below the eyebrow, and parallel to this. From this incision he dissects downward, keeping close to the skin, to within a quarter of an inch from the lid margin, and then makes a pocket under the frontalis, beneath the centre of the brow.

Second Stage.—He then cuts through the fibres of the orbicularis in a horizontal line about 3 mm. above the upper border of the tarsus, and through the orbital fascia, laying bare, at once, the insertion of the levator into the tarsal plate.

Third Stage.—He now passes a squint hook under the tendon, and, drawing it forward, divides it about 4 mm. from the tarsus.

Fourth Stage.—Now, taking the suture, he passes both needles through the flap of tendon, so as to leave a loop on the anterior surface, and carrying them upwards into the pocket under the brow, he makes them emerge through the skin above. In the same way the second suture is passed. When these are drawn taut, the tendon flap is brought into contact with the deep surface of the frontalis and becomes attached to this.

Fifth Stage.—The skin wound is sewn up.

Angelucci recommends that the final adjustment be made some days after the operation, but it would seem unwise in this as in other operations to interfere at such a date with the new-formed adhesions.

The disadvantages of his operation are that it is not possible if the levator is wholly absent, and that it effaces to some extent the normal fold of the lid. Sourdille's (14) method aims at avoiding this slight deformity.

Sourdille's Operation

First Stage.—The same instruments are needed. The surgeon makes an incision about an inch and a quarter long, curved so that its two extremities are some 3 mm. below the brow and the summit of the convexity a little above it. The incision is deepened through the fronto-orbicularis. The flap thus marked out is dissected up, so as to lay bare the orbital fascia just below the bony margin of the orbit. A pocket is made under the frontalis.

Second Stage.—He now cuts through the fascia quite close to the bony attachment; a few lobules of fat present in the wound; these are pushed on one side and the tendon of the levator comes into view. The surgeon passes the squint hook behind this and pulls it well out of the wound.

Third Stage.—Then, taking a doubly-armed suture, he pierces one side of the tendon from behind forwards with both needles, and then, carrying them upwards, crosses the threads and pierces the tendon again with both needles at a higher level (suture "en X"). A similar suture is passed at the other side of the tendon.

Fourth Stage.—The tendon is divided behind the hook and the needles carried up into the pouch under the frontalis, to emerge on the skin after perforating this muscle.

Fifth Stage.—Lastly the skin wound is closed.

By incising the fascia close to the bone, Sourdille thinks that

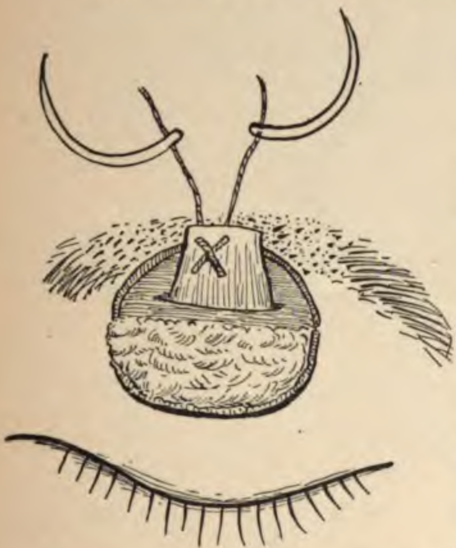


FIG. 40.—Sourdille's operation. The skin flap is turned down and the tendon of the levator drawn through an incision in the orbital fascia.

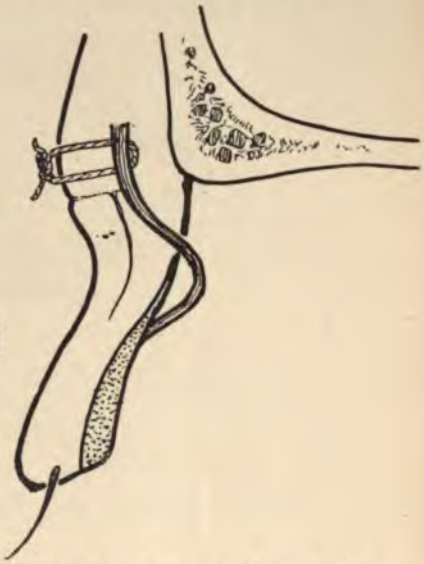


FIG. 41.—Diagram to show relations in the final stage of Sourdille's operation.

the lower part will act as a pulley round which the tendon of the levator can play. At the same time the fold of the lid is not obliterated. Clearly this operation, also, is inadmissible, if the levator is absent.

GROUP 3.—Operations making use of the superior rectus (methods of Motais (15) and Parinaud).

Motais' Operation

The method of Motais is, theoretically at all events, in some respects more scientific than those others which we have already discussed.

Instruments.—Sharp hooks, squint hook, scissors, fixation forceps, scalpel, needles and needle-holder.

The operation is divided into several stages. A general anæsthetic is not always necessary, and when it can be dispensed with the surgeon is much better able to judge of the probable success of the procedure.

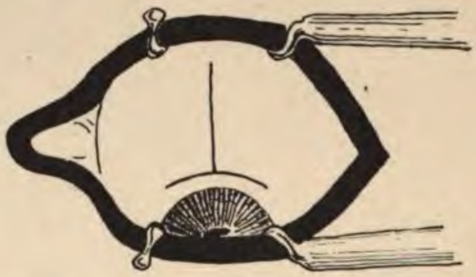


FIG. 42.—Motais' operation. Incisions in the conjunctiva.

First Stage.—The upper lid is everted and drawn upwards by a sharp hook, and the globe of the eye is drawn down by another, so as to expose the whole cul-de-sac of the conjunctiva. A horizontal incision about 15 mm. long is made in the con-

FIG. 43.—Motais' operation. Median slip of tendon marked out.

junctiva over the insertion of the superior rectus muscle, and from the middle of this a second is carried upwards vertically until it reaches the tarsus. Then the conjunctiva and the capsule are dissected away from the tendon by scissors.

Second Stage.—The surgeon passes a squint hook under the bared tendon and depresses the globe with it, removing the

sharp hook from the sclerotic; then seizes the middle fibres of the tendon 2 or 3 mm. from its insertion and divides them transversely, making an incision 3 mm. long. From the extremities of this transverse incision he makes other vertical incisions 10 or 12 mm. in length, so as to isolate the middle portion of the tendon, which remains attached to the muscle only by its posterior (upper) end.

Third Stage.—A small incision is made through the orbital

FIG. 44.—Diagram of parts in final stage of Motais' operation.

fascia just above the tarsus, and the anterior surface of this plate is cleared slightly.

Fourth Stage.—Through the flap of tendon close to its anterior extremity, and from the superficial to the deep surface, are passed two needles at the ends of a single silk suture, so that the tendon flap is held by a loop of silk. These needles are then passed through the hole in the orbital fascia, and made to perforate the tarsal cartilage from before backwards at a

point varying according to the effect required. The ends of the suture are tied over the conjunctiva, and the effect can be immediately observed; if the lid is not sufficiently raised the needles may be withdrawn through the tarsus and reintroduced nearer the fissural margin. If the opening is too wide, the suture may be slackened a little.

Fifth Stage.—The conjunctival wound is sewn up.

The operation is not much more difficult than advancement, and seems to have many advantages. It ensures that relation between the direction of regard and height of the lid which during waking hours at least is almost constant, but it has some disadvantages and risks; the knot on the mucous surface of the lid has in some instances caused very troublesome ulceration of the cornea, which has seriously interfered with vision afterwards.

In the practice of the originator no difficulty has followed in regard to weakening the elevators of the globe, but others have found the upward movement impaired, and the patients have complained of troublesome diplopia on looking up.

Parinaud's (16) **Operation** has a somewhat similar form, and is based on the same principle, *i.e.* the use of the rectus superior.

Instruments.—The same instruments are necessary.

First Stage.—The upper lid is everted. The surgeon grasps the conjunctiva near the upper edge of the tarsus and makes a horizontal incision through the mucous membrane parallel with the tarsal plate.

Second Stage.—Rotating the eye downwards with forceps or, if necessary, with the sharp hook, he searches for the tendon of the rectus through the incision just made, dissecting up the conjunctiva as far as may be found requisite.

Third Stage.—Taking a suture armed with two needles, he passes it under the muscle and the adjacent capsule. Each needle, then, is made to perforate the conjunctiva near the edge of the wound, and then passes through the tendon of the

levator palpebræ on to the anterior surface of the tarsal plate, between which and the skin it travels to the lid margin, coming out close to the lashes. The points of exit should be about 7 or 8 mm. apart. The ends are tied over a piece of drainage tube.

Comparing these two cognate methods, we see that in the latter the muscle, the rectus superior, is less disturbed than in the former, and therefore the results are less likely to include permanent diplopia on looking upwards from weakening of the elevator. On the other hand the adhesion between the lid and the adjuvant muscle is less close in the operation of Parinaud than in that of Motais.

It is clear that neither of these methods are applicable unless the rectus superior is normally developed. Unfortunately, since this muscle and the levator are parts of a single muscular sheet, both are not infrequently affected together.

We have already mentioned some other defects: the liability to disturbance of the muscular equilibrium is enough to act as a great deterrent to the general use of these procedures.

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CHAPTER III

OPERATIONS ON THE LIDS

A SHORT preliminary sketch of the structure of the lids must precede any account of the various operations which have been devised to correct their diseased conditions.

The lids are made up of a number of planes of tissue. The skin is very thin and supple, covered by very fine down, but having no hairs of any size (except the eyelashes at the margin). There is practically no subcutaneous fat; the subdermal connective tissue is very lax, so as to allow free, rapid movements. Into this tissue effusion of blood or lymph may take place very rapidly and copiously; but it cannot spread back easily into the orbit, because the mouth of this cavity is closed by a strong fascial sheet. Hence inflammation of the eyelids is rarely followed by orbital cellulitis.

Under the cellular tissue, but superficial to the fascial sheet just mentioned, lies the orbicularis palpebrarum, a well-marked circular muscle surrounding the palpebral fissure; internally and externally it is anchored to the bone by a fibrous band or tendo oculi; the internal of these is much the stronger, and passes across the anterior surface of the lacrymal sac to the nasal process of the superior maxilla.

Above and below, the fibres of the muscle are connected with the other superficial muscles in the surrounding parts.

Under the orbicularis is another plane of cellular tissue, which separates the muscle from the skeleton of the lids, the so-called tarsal cartilages or plates.

These are two masses of dense fibrous tissue, crescentic in outline, extending from the palpebral aperture into the lids; the upper is the larger and stronger. They fuse at the inner and outer canthi, where they are connected with the tendines oculi. If we trace them away from the fissure, we find that they thin out, at first gradually and then somewhat suddenly, into the fascial sheet which was spoken of above as closing in the orbit, and thus they are attached all round the bony margin.

The cellular interval in front of the tarsal cartilage is shown on the edge of the lid by a thin "grey line" behind the lashes. This line forms one of the most important landmarks in all lid operations.

A few points in relation to all the plastic operations on the lids must always be in the surgeon's mind. The incisions which mark out the flaps must be planned with care before the actual operation is undertaken, so that the flaps may when necessary be made and placed in their new position as rapidly as possible. As a general rule they are almost entirely separated from the body, and therefore possess little vitality. It is all-important, therefore, that they should be shaped and fixed in their new position with as little handling and bruising as is possible, and that the fixing sutures should be as few as is consistent with safety. All such operations must be aseptic.

For most of them a general anæsthetic is desirable. The performance cannot be hurried. Each step must be made accurately and carefully; on the proper performance the whole success of the operation depends.

Free bleeding would greatly interfere with the comfort and convenience of the surgeon. The operations are usually made "bloodless" by the use of Snellen's clamp.

In passing sutures, it is well, when possible, to pierce the movable flap first, and then to pass the suture through the lid at the selected point.

The first dressing should be left on for two or even three days without disturbance; at the end of three days it is usually

safe to remove superficial sutures, but deep ones may be left in for five or seven days.

Congenital Deformities

Congenital deformities of the lids, of sufficient importance to need operation, are among the rarities of ophthalmic surgery. When they exist they may affect the lid in almost any part; the commonest deformities are, perhaps, the following: epicanthus, coloboma, distichiasis, and maldevelopment of the puncta lacrymalia and canaliculi. This last condition will, most naturally, be dealt with under the head of the lacrymal apparatus.

Epicanthus may be divided into two varieties, which may be called: (1) simple or temporary, and (2) permanent or "mask-like" epicanthus. The former is found, usually in young children, as a small fold of skin with the free concavity downwards and outwards, bridging over the inner canthus, and thus giving rise to a trifling deformity; rarely the fold looks upwards and outwards.

It can at once be made to disappear by pinching up the skin over the bridge of the nose, and in most cases it vanishes spontaneously with the growth of the child as the bridge of the nose develops.

It is, therefore, most inadvisable to operate during childhood, unless and until it has become clear that no improvement is to be expected from natural growth. Should an operation have been performed and the bone undergo its normal development afterwards, the scar will yield and from a line, become an area, which from its prominent position is more disfiguring than the condition for which it was undertaken. If, owing to any defect of bony growth, the failure of disappearance is permanent, some operation may be justifiable.

The procedure most frequently adopted is that devised by Von Ammon.

Von Ammon's Operation

Instruments.—Scalpel, dissecting forceps, scissors, needles and holder.

First Stage.—The surgeon estimates the amount of skin, which must be removed, by pinching it up over the defective bridge of the nose. He marks out the extent of this area with a pencil.

Second Stage.—With the scalpel and forceps he excises the fold marked out.

Third Stage.—He brings the edges of the wound together with several sutures. The tension of the stitches holds the folds stretched out. Healing is usually rapid, and the resulting scar is a mere line.

De Wecker's Operation

A slight modification of this method was described by De Wecker. The same instruments are needed.

First Stage.—The surgeon picks up the fold of skin over the bridge of the nose, as in the former method, and pushes two or three needles through it, from side to side, leaving them transfixing the fold.

Second Stage.—The fold, thus isolated, is cut off with scalpel and forceps.

Third Stage.—The needles and their sutures are now drawn through completely and the wound closed by tying the ends of the threads.

Wicherkiewicz' Operation

Wicherkiewicz (1) published a short account of an operation which he has devised for this deformity. Since the fold covers the inner canthus and runs down and up into the lids, the surgeon should endeavour by his operation to affect the centre of the fold more than the lateral regions. Wicherkiewicz has had this in view.

First Stage.—From a point about 1 cm. away from the internal

canthus, and in the same horizontal line, the surgeon makes two diverging incisions, enclosing an angle of about 60° and reaching almost to the base of the fold. From the extremities of these two others are cut converging to a point about 5 or 6 mm. nearer the canthus, and thus meeting at a larger angle than the first. These four lines mark out a trapezoid of skin, with a re-entering angle towards the base of the fold.

Second Stage.—The skin contained within this area is then

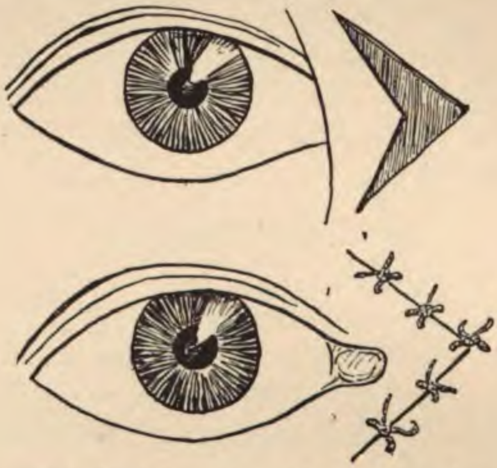

FIG. 45.—Wicherkiewicz' operation. The upper figure shows the area of skin removed; the lower, the final result.

removed, and the edges of the raw area brought together by means of five sutures.

In the more severe degrees epicanthus is combined with imperfect development of the face, and is, in fact, only a part of this condition. The skin is tight and unwrinkled; the palpebral fissures are small, and there is a want of expression and general fixity of appearance which has suggested the name "mask-like" epicanthus for the state. It has been noted in some cases that there is, associated with the deformity of the lids, wrinkling of the brows from overaction of the frontalis muscle. Whether this overaction is secondary to the maldevelopment of

the lids, or primary, arresting by pressure the proper growth of the bones, as some have suggested, may be left undecided. There is no doubt that all the bones of the region, as well as the skin and muscles, are abnormal. The result is an undue tightness of the skin.

In such cases Foggin (2) has proposed to deal with the deformity in the following way, with the object of slackening the tension of the tissues and thus removing the obstacle to the normal bony growth.

Foggin's Operation

Instruments.—A tenotomy or linear cataract knife, needles, needle-holder, specially shaped lead plates over which to tie the sutures.

First Stage.—The surgeon passes the knife through the skin at the side of the glabella, and separates, subcutaneously, all parts from the nasal bones and their immediate neighbourhood.

Second Stage.—He is now able to pick up a fold of skin in the region of the defective bridge of the nose large enough to form a bridge.

He passes the sutures through this fold from side to side, and ties them through holes in the specially prepared lead plates.

Coloboma

Coloboma of the lid is never a common deformity, and very seldom so marked as to require operation. When it occurs it is found as a more or less deep notch in the upper or the lower lid. Although it would seem probable that the notch be due to some imperfect closure of the facial clefts, yet it is hard to explain the varieties of position by any reference to the known facts of the development of the face. The malformation of the lid is not unfrequently associated with coloboma of the choroid, which, of course, cannot be due to defective closure of the facial clefts.

The coloboma is usually a mere nick in the lid margin, only

to be discovered on careful observation and readily passed over; such, therefore, needs no treatment. If the notch be so large as to expose the cornea permanently in whole or part, it will probably be advisable to close it, not only for the deformity, but also to prevent injury of the cornea from foreign bodies. The operation may be considered as a form of tarsorrhaphy, a procedure which will be described fully later.

The margins of the gap must be pared and the raw edges brought together and fixed accurately in apposition by several sutures.

The chief difficulty of dealing with coloboma of the upper lid is to make a satisfactory margin by operation. Peschel (3) describes a method of procedure which he adopted in a case of traumatic coloboma, with good results; the chief point in it is, that he makes a rectangular gap in the tarsal plate, by excising the triangular area on each side of the unclosed wound, and fills it by displacing a similarly shaped piece of the cartilage downwards. The operation seems, at first sight, unnecessarily complex, but the regularisation of the margin is a point of real importance, and further experience of the operation is necessary before it can be decided whether it be preserved or not.

Distichiasis

Occasionally the lashes are arranged in two rows, of which the posterior is inverted and brushes against the eye. This condition is known as distichiasis, and requires operation sometimes. It may be considered for practical purposes a subvariety of trichiasis, and should be dealt with by one of the methods which will be described under that head.

Lastly, the puncta lacrymalia may be congenitally deformed. These conditions will be found treated of in the chapter on the lacrymal apparatus.

Operations for Acquired Disease of the Lid

The conditions of the lids in disease which may require operation are numerous; among the most important are two,

which relate chiefly to the position of the lid-margin and the lashes.

Often, from one cause or another, the lashes are turned inwards and brush against the globe. This condition, known as trichiasis, or, in the more marked degrees when the whole margin is inverted, as entropion, is both inconvenient and dangerous—inconvenient because the brushing lashes give rise to constant discomfort; dangerous because the friction gives rise to opacity and frequently to ulceration of the cornea, which may be entirely destroyed as a result.

It is therefore necessary, as well for hygienic as for cosmetic reasons, to correct any such deformity.

On the other hand, the lid may fall or be drawn away from normal apposition with the globe—a condition known as ectropion, because the palpebral conjunctiva is turned outwards.

The eye here is unusually exposed to injury owing to the absence of the normal protection. The cornea is in some cases always exposed, and therefore its epithelium becomes dry and thickened.

If the lower lid be affected there is more or less constant overflow of tears, which causes eczema of the face, and the exposed mucous membrane is constantly inflamed and unsightly.

Entropion

Entropion is due either to irregular spasm of the orbicularis or to cicatricial contraction of the deeper structures of the lid. Spasmodic entropion always affects the lower lid, and is rare except in advanced age. The tarsal cartilage in the upper lid is too strong for the orbicularis to bend.

It often happens, when in an old person the eye has been kept bandaged for some days, as after an operation, that, when the bandage is removed, the lower lid is found doubled on itself and its lashes turned downwards into the cul-de-sac.

When this occurs, it is always a troublesome complication, and may lead to the patient's undoing. The lashes not only act

as a mechanical irritant, but often introduce micro-organisms into the eye, which may interfere with the normal healing.

Sometimes the lid may be replaced by simple means until the bandages can safely be discarded. Then no operation will be necessary, the recovery being spontaneous. Reposition can always be effected temporarily by the finger, drawing the skin of the lid downwards and rolling out the inverted margin and the lashes.

When thus replaced, the lid may be held in position by contractile collodion or strapping; or if these are insufficient, sutures may be passed as follows:—The surgeon takes a suture with a needle at each end; he makes one of the needles pierce the skin close to the lashes, and descend subcutaneously in a vertical direction to the lowest fold of the lid, where it emerges. The second needle is passed subcutaneously along a parallel line, making entrance and exit at points about one-eighth or one-sixth of an inch from the course of the first needle.

One such suture is passed at each extremity of the middle third of the lid. When pulled tight and tied round a drainage tube, the skin of the lid between the points of entrance and exit is wrinkled up into folds, and the lashes are everted.

These sutures should be left in until the healing of the original wound is completed and the bandages are finally left off.

If the vicious habit still continues, and the entropion returns after the removal of the sutures, the redundant skin and the underlying portion of the orbicularis must be removed.

For this operation a general anæsthetic is usually necessary, but it may sometimes be performed without.

The instruments needed are a Beer's knife, curved scissors, dissecting forceps, needles and needle-holder; a horn speculum may be added.

An incision is made about 3 mm. from the lashes in the whole length of the lid. This is made most easily by stabbing the Beer's knife through the skin with the edge forwards, and then running it along as far as is necessary, the back resting on the lid.

A second crescentic incision is made (more readily with scissors than with a knife) below this, joining the first at each extremity. The contained skin and the underlying muscle are rapidly removed, and the edges brought together by three or four sutures.

When the tissues of the lid are very loose, it makes the operation easier to put them on the stretch by the flat horn.

The resulting scar is small and readily overlooked. The cure is usually complete and permanent.

Cicatricial Entropion

Cicatricial entropion depends for the most part on one of two causes—it is due either to some contraction of the fibrous tissue about the individual hair-follicles, or to the deposition and subsequent contraction of new fibrous tissue, laid down during an attack of chronic conjunctivitis, in the subconjunctival tissue and the posterior layers of the tarsal plate. Clearly the result will differ in degree with the form and extent of the contraction.

In the former instances the tarsal cartilage will preserve, almost if not quite intact, its normal curvature; in the latter the bent tarsal cartilage will form a prominent angle, as the result of the forcible contraction.

Treatment will vary with the form and degree of deformity. The typical cause of the former variety of trichiasis—that in which the deformity is almost confined to the maldirection of individual lashes—is long-standing blepharitis. In such instances the lid margin is much deformed, and treatment may be confined to the immediate edge without attacking the remainder of the lid.

Many operations have been devised, having for their aim the reconstruction of the normal lid margin, or merely the removal of the lashes from the danger zone.

When only a few cilia are malplaced, we may deal with them individually in many ways—by repeated epilation, by electrolysis

or excision of the affected bulbs, or by attempting to alter the direction of the several hairs.

Practically epilation is often the most convenient. The hair must be seized near the root with smooth forceps and drawn firmly out of the follicle; any jerk is liable to break the hair, whose sharp end will be more irritating than ever.

The removal of the hairs must be repeated as often as they grow, but patients soon learn to pull them out for themselves, and often become very skilful in the little operation.

It has been suggested that, since the faulty direction of the hair is largely due to the maldirection of the mouth of the hair follicle, we might make a new track for the lash which would modify its position.

To effect this we introduce a small curved needle down the opening of the hair follicle, and force it onwards to the point at which it is desired to bring the hair. We then thread the lash into the eye, and, withdrawing the needle, bring the lash into the new track; but, unfortunately, when the lash is thrown off the new hair will almost certainly retake the old curve.

A better method is destruction of the hair follicle by electrolysis.

If more than a few hairs, or if all in one region of the lid are affected, such methods as epilation and electrolysis are not advisable, since by removing the lashes they rob the eye of its normal guards.

The surgeon must, therefore, adopt some other method, so that the lashes may be preserved, but put into a position where they will not damage the eye.

The choice of the procedure will vary with the amount of deformity. It is necessary in all cases to be sure, if possible, that the cicatricial contraction has run its full course, otherwise an operation which is efficient when done may prove in six months entirely inadequate.

The earlier surgeons, in treating entropion, did not sufficiently recognise the importance of preserving the lashes. Flarer, indeed, suggested the excision of the whole lash-bearing zone, by two incisions, one in the grey line and the other above the roots

of the hairs on the skin; the inconvenience of the results were soon apparent, but the operation is of historical importance, because it is the ancestor of many others, having for their aim the removal of the lashes from the margin. One of the first modifications, still not infrequently performed, is that of Arlt. In this, the lash-bearing area is raised as a bridge from the lid by means of two incisions; a piece of skin is excised from the lid above the bridge flap, and the bridge is reseated higher up. There is left a raw area near the lid margin, which fills up by granulation.

This involves a somewhat lengthy convalescence, and various methods of filling the gap have been suggested. Some fill with skin; this has a radical defect, since the downy hairs of the skin are brought into contact with the cornea, at the lid margin, and give rise to as much irritation as the lashes. Others fill with mucous membrane, a much better plan, and one most valuable when the deformity depends on malformation of the lid margin only.

Van Millingen's operation, or some modification thereof, is the best way of applying this method. It is simple, applicable to either lid, and the convalescence is short.

It has already been remarked that the chief cause of cicatricial entropion is to be sought in the increased curvature of the tarsal plate which follows the deposition of fibrous tissue in the deep subconjunctival layers; so long as this structure retains its faulty shape no real cure is possible. The tarsus in old trachoma forms a prominent angle directed forwards: this angle is situated some five millimetres above the free edge of the lid, at the point where the normal curve of the lid is steepest.

Unless this malformation be corrected, the entropion cannot be cured. The offending angle has been attacked from both its cutaneous and its conjunctival surfaces: the latter procedure is the characteristic feature of the operations of Williams and Lagleyze; the former route is chosen by Streatfield, Snellen, Knapp, and Barrett.

The principle of the former operations is to divide the tarsal

plate from the inner side and to trust that the cicatricial material thrown out in the course of healing will act as a wedge between the edges of the plate and thus correct the curvature, an expectation which is not always justified, especially when the deformity is extreme.

On the other hand, the surgeons who attack the cartilage from the anterior surface, for the most part actually excise so much of the tissue as may be necessary to allow the plate to resume its proper curve; this method, therefore, if a little more severe, is better able to deal with the worst cases. There is another point, too, which must be borne in mind. If the tarsus is divided from the conjunctiva, the wound cannot be kept aseptic, because it is in communication with the conjunctival sac, which in these patients is always swarming with micro-organisms. Sometimes there follows some painful suppuration of the lids.

Anagnostakis tried to bend the cartilage straight by increasing the tension on its anterior surface; he stitched the skin up tight to the upper border of the cartilage without any division of the latter His method found few followers, but has been utilised, in conjunction with division of the tarsal plate, by Williams, and in almost its original form by Hotz.

Operations for Cicatricial Entropion

Group 1.—Destruction of the individual affected hairs.

Group 2.—Reposition of individual hairs.

Group 3.—Complete removal of the lash-bearing area.

Group 4.—Removal of hairs from danger-zone.

- (*a*) Removal leaving a raw surface at the lid margin.
- (*b*) Raw surface filled by skin.
- (*c*) Raw surface filled with mucous membrane.

Group 5.—Correction of faulty curvature of tarsus.

- (*a*) By tension (method of Anagnostakis).
- (*b*) By division of the tarsus from the conjunctival surface.
- (*c*) By division of the tarsus from the anterior surface.

The operations belonging to the first three groups have been sufficiently dealt with in the general summary of methods. We may pass, then, immediately to the operations of Group 4.

Arlt's Operation

Instruments.—Scalpel, Snellen's clamp, dissecting forceps, scissors, needles and needle-holder.

First Stage.—The surgeon makes an incision in the grey line throughout the whole length of the lid, of a depth sufficient to pass above the hair follicles, *i.e.* about 4 mm. deep.

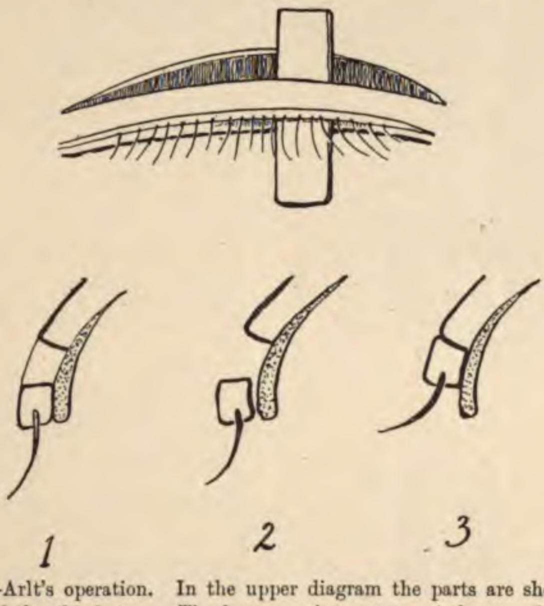

FIG. 46.—Arlt's operation. In the upper diagram the parts are shown at the end of the *third stage*. The lower sections represent the *second*, *third*, and *fourth stages*.

Second Stage.—He marks out on the lid a semilunar area, having its lower border horizontal, about 5 mm. above the free border of the lid, extending the whole length of the lid, and having its greatest height about 5 mm.

Third Stage.—He excises the skin within the semilunar incisions, leaving a large raw surface.

Fourth Stage.—He draws up the flap of skin which bears the lashes and stitches it to the upper margin of the raw surface.

This method is fairly effectual as a means of lifting the cilia from the danger zone, but it entails a somewhat tedious convalescence, since the raw area which is left at the lid margin after lifting up the cilia is only slowly covered by epithelium by extension from the surrounding parts.

GROUP 4 (*b*).—The operation has been modified in various ways. Of these, Spencer Watson's (5) method deserves notice.

Spencer Watson's Operation for Complete Trichiasis

The same instruments are needed.

First Stage.—The surgeon makes an incision above the roots of the lashes down to the tarsal cartilage, along the whole length of the lid, and, by a second incision in the grey line, separates a long bridge of tissue which contains all the hair follicles.

FIG. 47.—Spencer Watson's operation. *Second stage.*

Second Stage. — A third (curved) incision is made, starting about 6 mm. from one extremity of the first, and, after enclosing an island of skin, ending at about 6 mm. from the opposite extremity; this, like the first, goes down to the tarsal cartilage. The tissues above the wound are lightly dissected back.

Third Stage.—Into the gap thus made the bridge of skin which bears the lashes is passed, over the island, and the parts

are secured in their new position by several points of suture. The lower margin of the island is united to the tissues of the lid which formed the posterior lip of the wound in the grey line, and forms the margin of the lid.

This modification is a great advance on the original operation of Arlt. No raw surface is left which has to be covered by

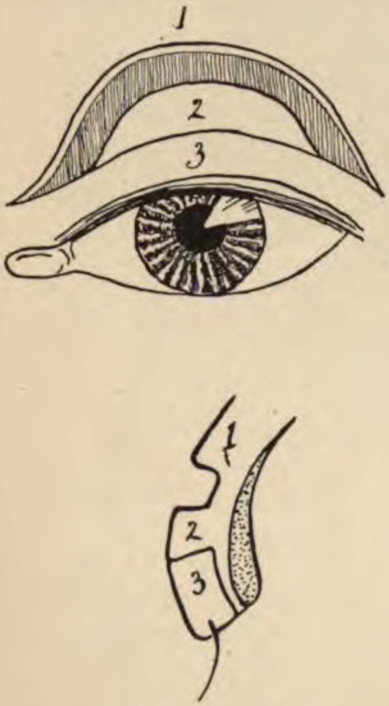

Fig. 48.—Spencer Watson's operation. *End of second stage*, showing the gap made by dissection above the island.

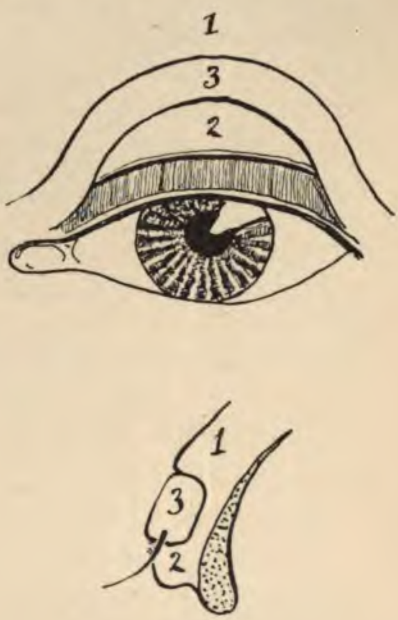

Fig. 49.—Spencer Watson's operation. *Third stage*, showing raw area left at lid margin.

the slow growth of epithelium from the edges, and, further, the tension of the stitches tends to evert the lower edge of the tarsus.

On the other hand, it has one serious disadvantage: the island of skin which is brought down from the lid to form the new lid margin remains skin in all respects, and gives rise to

much irritation of the eye by means of its fine downy hairs. This irritation may be a little less than that for which the operation was performed.

In some cases of entropion the deformity affects only one or other end of the lid; the lashes at the inner or outer canthus are incurved, while the remainder have a normal direction. In such it is specially tempting to choose the "partial" operation of Spencer Watson, but the surgeon must bear in mind the caution already given, and must be sure that the contraction has run its full course; if further contraction occur, it is certain that the deformity, though remedied at the time, will soon reappear, and the apparent success will be changed to obvious failure.

It has been implied in the preceding lines that the method is only suitable for those cases in which the canthal lashes alone are affected. A glance at the design of the operation will show the reason.

Spencer Watson's Operation

Instruments. — Snellen's clamp, dissection forceps, scalpel, scissors, needles and needle-holder. The Snellen's clamp, though not absolutely necessary, is a great convenience for these delicate operations, as it makes the field bloodless. It must be put on and screwed tight after the patient is anæsthetised.

First Stage.—The surgeon divides the affected area of the lid into two planes by making an incision in the grey line extending a little beyond the region of the inturned lashes. He gradually deepens it until it is about 6 mm. in depth, being careful to keep behind the hair follicles and close to the tarsal cartilage.

Second Stage.—In the anterior plane of the region thus divided two elongated flaps are marked out and separated—the lower, about 5 mm. in breadth in its whole extent, containing all the affected hair follicles, and having its base toward the

centre of the lid; the upper, a very elongated triangle, narrowing from its base, about 3 mm. wide, where it is attached near the canthus, to its apex, directed toward the middle of the lid.

The incisions which mark the flaps out may be made with sharp scissors more evenly than with a knife.

The flaps are attached to the body only by their bases, and therefore have very little vitality. The surgeon must take great care while making them not to bruise the tissues more than is unavoidable, and must notice that the flap which carries the lashes is attached towards the centre of the lid. If the flaps are cut in the reverse direction, the line of the lashes is broken and the deformity is accentuated.

Third Stage.—The flaps are now shifted; the lower is slid

FIG. 50.—Spencer Watson's operation (partial). The flaps are shown marked out at R and transposed at L.

upwards under the upper so that the lashes are lifted out of the dangerous position, and the upper fills in the gap left between the lashes and the free border. A suture at the extremity of each flap fixes them to their new bed. If necessary, other additional stitches may be used to hold the parts in position, but the delicacy of the flaps forbids the use of many. A dry dressing should be kept on for about four days, at the end of which the stitches may be removed.

This little operation has many good points in suitable cases, but it will be noticed that the tissue which is brought down to the edge of the lid is true skin, covered with down; and if there be any further contraction, this will be inverted and may be very irritating.

In the original description of his operation, in vol. vii. of the

Moorfields Reports, the flaps are cut so that the line of the lashes is broken ; in the particular case which was thus operated on the lashes were in two distinct rows; the lower fell over and hid the break. Spencer Watson suggests the placing now usually adopted, and points out that by making the flaps long the operation may be extended to cases in which the whole lid is affected, thus anticipating the methods of Gayet and Vossius.

Group 4 (*c*).—If the surgeon desire to make a new margin to the lid, it is better to choose an operation such as that of Van Millingen (7), and called "margino-plasty." Van Millingen suggested that the lid margin should be reconstructed from mucous membrane taken from the patient's lip or some other convenient place. His method has, in turn, been modified by many surgeons, who have striven to make the implantation of the flap more speedy and secure: the special modification which we have found useful was suggested by Mutermilch (8).

Van Millingen's Operation (modification of Mutermilch)

For this the same instruments are necessary as before.

We may consider the procedure in four stages:—

First Stage.—An incision is made in the grey line of the lid-

Fig. 51.—Van Millingen's operation.

margin along the whole length, which therefore divides the tissues into two planes; the one in front should contain all the hair-bulbs, while the posterior consists of the tarsal cartilage and conjunctiva. The wound is cautiously deepened along its whole length until it is about 3 mm. deep. It forms a very

elongated oval, with pointed extremities. By small incisions at the extremities the wound is made rectangular, so as to offer a shape more easily filled by a mucous membrane flap. The surgeon must now carefully examine the posterior lip of the wound to see if any hair-bulbs have been left adherent to the tarsal cartilage. Each so found must be carefully dissected out.

Second Stage.—The next stage is that of placing the sutures to hold the flap in position, and this is the chief advance of Mutermilch's method. The flap to be transplanted is, as will be seen, completely separated from all its attachment, and therefore has a low vitality. If it is much wounded by needles, etc., it is not unlikely to die. On the other hand, unless it is

Fig. 52.—Van Millingen's operation. Mutermilch's modification and sutures

kept firmly in contact with living tissues, it receives no nourishment, and cannot fail to succumb.

These two important points are both satisfied by the method now to be described. The surgeon passes a needle with a fairly long suture through the anterior plane of tissue and brings it out close to the skin at the anterior lip of the wound; then, reintroducing the needle close to the skin in the posterior plane, he brings it out on the conjunctival surface.

In this way a loop is left lying free across the floor of the marginal wound. Three or four such sutures are passed at equal intervals, about 8 mm. apart. To prevent the loops becoming entangled, it is well to pass under them a hook or a pair of forceps, which must then be entrusted to an assistant. All bleeding must be carefully stopped.

Third Stage.—The surgeon now marks out the flap of mucous membrane, usually on the lower lip of the patient. It must be about as long as the incision in the lip, and about 5 or 6 mm. broad. It is most easy to cut the two long incisions with a Beer's knife, running the point just under the mucous membrane, with the back turned against the tissues of the lip. The two short terminal incisions and the exsection can be performed with scissors.

The flap should be mucous membrane only. The surgeon spreads it out on his finger, with the mucous surface against the skin, and rapidly cuts off all the submucous tissue.

Fourth Stage.—The flap is now slipped under the loops of the sutures, so that the two raw surfaces of the flap and the wound are in contact. Then the ends of the sutures are drawn taut and the flap pressed firmly down into the bed prepared for it.

The sutures are not tied, but the ends fixed by collodion to the brow and cheek. A dry aseptic pad is bandaged over the eye, and should be left untouched for three days. At the end of that time the graft should have taken hold, and on the fifth day the sutures may be drawn carefully out.

The chief point in the success of the operation is the accurate adjustment of the flap to the raw surface. To favour this, all bleeding from the wound must have stopped before the flap be placed in position, or the blood collecting will raise the new graft from its bed.

Some operation such as the last is specially suitable for cases of deformity of the lid margin from old blepharitis.

Story's Operation for Entropion ("St Mark's Hospital Operation")

Story (9) employs the operation of margino-plasty (or, as Benson calls it, blepharoplasty) in a rather different form.

Instruments.—Snellen's clamp, von Graefe's knife, lip clamp, scissors, dissecting forceps, needles and needle-holder.

First Stage.—The surgeon having placed the clamp on the lid,

makes with the knife an incision in the grey line, along the whole length of the lid, splitting this so that all the hair bulbs are in the anterior layer. If any are left in the posterior, they must be removed by dissection. Story recommends that this incision should not be deep. Benson (10) lays stress on the great depth of the incision, which should be, he says, at least a quarter of an inch deep. In each case it must be the same depth throughout. No terminal incisions are made.

Second Stage.—A clamp is now applied to the patient's lip, and two parallel incisions are made through the mucous membrane with the knife marking out an area rather shorter than the lid wound. The ends of the two incisions are then joined by short converging cuts, so that the whole flap thus marked out is in shape a rectangle with an equilateral triangle at each end, the length being about five times the breadth.

Third Stage.—This flap is now dissected up with scissors and forceps, and laid, mucous surface down, on the surgeon's finger. From the deep surface he cuts away all the submucous fat and connective tissue.

Fourth Stage.—Story fixes the flap into the wound in the lid margin in the following way. He takes a silk suture in a fine curved needle and ties a knot on it at some little distance from the end; then he passes the needle through the flap from its superficial to its deep surface until the knot brings up against the mucous membrane.

This done, he enters the needle into one end of the wound and brings it out on the edge of the lid beyond the incision. A similar suture is used to secure the other end of the flap in place. The extremities being fixed, the edges are also secured by two or three points of suture to the corresponding edges of the wound.

When the clamp is taken off there is pretty free hæmorrhage, but this does no harm.

The flap, immediately after the operation, is quite white in colour; within twenty-four hours it becomes almost black, and in another twenty-four it has regained almost its normal tint (Benson).

Very recently, Dr Harrison Butler (11) has suggested an important modification of Spencer Watson's partial operation: he has found the chief drawback to be the fine hairs on the skin flap which is transported to the lid margin, and proposes to avoid this inconvenience in the following way. After cutting the flaps in the usual way, he truncates the upper triangular flap, leaving its base some two or three millimetres long. When the lash-bearing skin is sutured into position, this short flap is brought down and fixed between the apex of the former and the tarsal plate. By it the lashes are held away from the lid

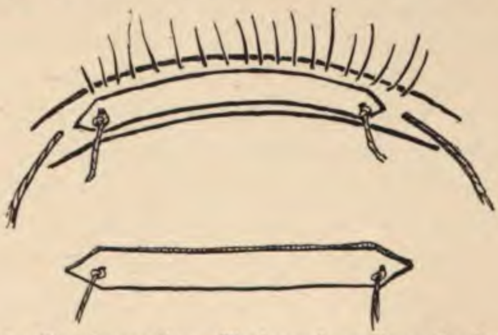

FIG. 53.—Story's operation. The lower figure shows the shape of the mucous membrane flap.

margin, but there is left a raw triangle, corresponding to the part abscised from the upper flap.

This is filled with a strip of mucous membrane.

GROUP 5 (*a*).—The operation of Anagnostakis (12) depends for its value on fixing the area of skin which bears the lashes up to the superior part of the tarsal plate; by the tension thus established the inversion is overcome, and the cartilage itself straightened to some extent.

Operation of Anagnostakis

Instruments.—Horn-plate (or Snellen's clamp), scalpel, dissecting forceps, scissors, needles and needle-holder.

First Stage.—An incision is made in the skin along the whole length of the lid, about 6 millimetres above the free margin.

By drawing on the skin, the wound is spread out so as to expose a large surface of the orbicularis palpebrarum.

Second Stage.—The exposed muscular fibres are excised, so that the tarsal plate is laid bare in almost its whole extent.

Third Stage.—This consists in the passage of the sutures. Three are usually sufficient. Each is passed first through the upper part of the tarsal plate, entering and emerging on the anterior exposed surface, and taking firm hold of the fibrous tissue, thence it passes through the skin below the primary incision, near the roots of the lashes. When the sutures are tied the lashes are drawn up and everted. At the same time the tension on the stitches somewhat corrects the faulty curvature of the tarsal cartilage.

Hotz (13) has published a slight modification of this operation. The sutures are passed through the skin below the incision, and, after perforating the tarsus, as in the original method, come out through the skin again above the incision. When they are tied, the wound is closed by the same sutures, which tend to evert the deformed cartilage.

Gifford (14) describes the same operation, but adds an incision through the cartilage from the conjunctival surface. This procedure is, as a matter of fact, not original, as Williams of Liverpool had published an account of an exactly similar procedure as far back as 1882 in the *Liverpool Medico-Chirurgical Journal.* He, later, gave up this method in favour of the plan which appears on another page.

Schneller (15), in cases of severe cicatricial entropion of the lower lid (a somewhat rare condition), has proposed the following treatment.

Schneller's Operation

Instruments.—Scalpel, dissecting forceps, needles and needle-holder.

First Stage.—The surgeon makes, at distances of 2 mm. and 6 mm. from the free border of the lid, two incisions through

the skin. The upper is rather longer than the region inverted, the lower is a little less. Their ends are connected by two short oblique incisions. Thus there is marked out on the skin an island.

Second Stage.—The skin surrounding the limiting incisions is slightly dissected up, without interfering with the skin of the "island."

Third Stage.—By means of sutures, the marginal skin is brought over the enclosed "island," which acts as a wedge to force the margin of the lid into the correct position.

This operation seems to have few advantages.

Group 5 (*b*).—The essential point of the methods which form this group is the division of the cartilage from the conjunctival surface. In some instances, *e.g.* Williams' (16) method, the originator described it as a modification of an operation of another group, in this case of Anagnostakis'. The division of the cartilage, is, however, an essential point, and it seems best to take these operations in a separate class.

Williams' Operation

Instruments.—Scalpel, needles, needle-holder, small rubber drainage tube.

First Stage.—The surgeon everts the upper lid and divides the tarsus completely from side to side, placing the incision at the point where the curvature is most acute (usually about 4 mm. from the free margin). This allows the lid to retake its normal curve and the lashes to resume their normal position.

Second Stage.—The surgeon takes a needle and passes it, from behind forwards, through the lower piece of the lid, emerging on the skin just above the lashes; then passing it over a roll of gauze or a piece of drainage tube, he reinserts it through the skin and makes it take a firm hold on the deep structures, if possible of the tarsus. Three or four such sutures are passed; care must be taken that they have subcutaneous

courses of equal extent. The ends of the corresponding threads are tied firmly over a piece of small drainage tube, or, Williams advises, over a triangle of plaster, rolled up so as to make a roll tapering at each end and thickest in the middle.

By the tension of the stitches the tarsus is kept straight until the wound, which is converted from a line into a wedge-shaped space, is filled up by formative tissue. As this contracts, the deformity in part returns; the skill of the surgeon is shown in producing at the time of operation just so much eversion as will be counteracted by the subsequent retraction.

FIG. 54.—Williams' operation.

The advantages of the operation are its simplicity and the ease with which the effect can be adjusted. Further, the time of recovery is short: no tissue is removed; and if the operation fail, the subject is no worse off than before, and a more radical procedure may be undertaken. Williams has great experience of this method in Liverpool, where trachoma is rife among the Irish poor, and finds it almost always successful. The disadvantage common to this and most other modifications of Anagnostakis' operation is that the cellular tissue of the lid is laid open to the invasion of microbes from the conjunctival sac.

Lagleyze's (17) **Operation** is but little different from Williams' method.

Instruments.—Scalpel, needles, needle-holder. Five or six needles must be threaded on a single long thread.

First Stage.—The upper lid is everted so as to display the inner surface. The surgeon takes the needles in succession and passes them through the conjunctiva at the upper edge of the tarsal plate, and thence on along the cutaneous surface of the plate, to emerge at the free border of the lid behind the lashes;

the needles are not drawn through, but remain, transfixing the tissues.

Second Stage.—The surgeon divides the tarsus freely with the scalpel, cutting down on to the needles, which serve as a guide to show the required depth of the incision. It is necessary in this as in Williams' operation to divide the tarsal plate entirely from end to end.

Third Stage.—The needles are drawn through and the suture follows. The needles are then cut off, leaving in the lid loops of suture, in number one less than the number of needles. The ends of each loop are tied firmly over a piece of drainage tube. The tension produces a slight degree of ectropion, which corrects itself when the sutures are withdrawn seven or eight days later.

Green's (18) **Operation** is a modification of that of *Burow.*

Instruments.—Green recommends a special knife, with a rounded end, dissecting forceps, scissors, needles and needle-holder.

First Stage.—The surgeon inverts the lid and makes an incision through conjunctiva and tarsal cartilage, about 2 mm. behind the openings of the Meibomian ducts, in the whole length of the lid.

Second Stage.—Replacing the lid in its usual position, he makes two incisions in the skin, the lower about 1·5 mm. above the lashes, and the upper about 2 mm. above this, and excises the intervening skin. The undivided orbicularis remains joining the upper and lower segments, and separating the skin incision and the conjunctival.

Third Stage.—The sutures are inserted in the following manner. The surgeon makes the needle enter a little to the conjunctival side of the lashes and brings it out in the lower part of the skin wound. He then reinserts it at the upper part of this wound and passes it deeply upwards and backwards, grazing the anterior surface of the tarsal plate, and emerging through the skin about 10 mm. higher. Three such sutures are passed and are tied loosely.

Ewing (19) has devised a further modification.

He dissects up the conjunctiva before incising the tarsal plate, and completes the operation by suturing the flap of conjunctiva into the groove. He makes no skin incision, and inserts the sutures somewhat differently.

Insertion of Sutures in Ewing's Modification.—The part of the tarsus in connection with the hair-bulbs is turned forwards and the needle is passed into its cut edge near the orbicularis; it takes hold of the firm tissue and emerges again on the same cut surface; hence it is carried round the free margin of the lid, entered on the cutaneous surface in the line of the cilia and pushed upwards subcutaneously, to find exit about 5 mm. above the free margin.

Three such sutures should be passed, and tied over a roll of gauze.

Panas' Operation

Panas' (20) operation may be considered as in some sense holding an intermediate position between the methods just described and these following; it involves the division of the tarsal plate from the front, but the incision is carried through conjunctiva as well, and none of the tarsus is excised. The large wound is, by the division of the conjunctiva, thrown open to the invasion of micro-organisms.

Instruments.—Scalpel, dissecting forceps, scissors, needles, needle-holder, Snellen's clamp or metal spatula. (Panas advises that the latter be employed, and the lid, thus supported, handed over to the care of an assistant, who at once keeps the tissues stretched, and prevents troublesome hæmorrhage. Snellen's clamp seems equally able to fill these requirements, and, if of full size, allows free access to the whole of the tarsal plate.)

First Stage.—An incision is made some 6 mm. or 7 mm. above the free border of the affected lid, through skin and muscle, down to the cartilage in the whole length of the lid.

Second Stage.—The surgeon takes the upper lip of the wound in the forceps and makes a dissection upwards between the

orbicularis and the tarsus, exposing the whole of the surface of the latter above the first incision. Then, taking the lower lip in the forceps, he dissects downwards until he reaches the roots of the lashes; these must not be interfered with. It is important to make this dissection extensive, since the result of the operation depends largely on the cicatricial contraction of the wound thus made.

Third Stage.—The surgeon makes an incision through the tarsal plate and the conjunctiva. This must be made at right angles to the anterior surface of the tarsus.

Fourth Stage.—The sutures are now put in. The surgeon

FIG. 55.—Panas' operation.

FIG. 56.—Panas' operation. Thilliez' modification.

takes a needle and inserts it at the lid margin, just behind the lashes; he passes it on, close in front of the tarsal plate, to the wound, where he brings it out; then, taking it again in the needle-holder, he makes it perforate a part of the tarsal plate some millimetres above the horizontal incision and come out again on the anterior surface. When the ends of the suture are tied, the tarsus is bent into such a position that the lashes are everted. The ends of the suture are cut long and secured to the brow by collodion; three or four such sutures are needed. The tension on the threads brings the edges of the wound into contact, and no further stitches are required.

This method of operation is much used in France, but is comparatively little known in England.

There is one serious drawback to the operation: the lower part of the tarsus, completely separated from the upper, tends often to ride over it when the sutures are being tied, and thus the parts are fixed in a very faulty position. To remedy this defect, a slight modification of the operation has been suggested by Thilliez (21). He leaves in the middle a small part undivided, about 1 mm. or 1·5 mm. in width. This is sufficient to prevent the dislocation and shortening of the tarsal cartilage.

GROUP 5 (*c*).—This principle—the division of the tarsal cartilage—is a great advance on the methods which have been described hitherto, but its application in the last operations, *i.e.* from the conjunctiva, is not always satisfactory; the wedge of new-formed tissue which inserts itself during healing between the two parts of the cartilage contracts and allows the reappearance of the deformity. While, therefore, the method is often successful in mild cases, and at the worst does no harm, yet in the face of severe deformity we must seek a more thorough readjustment. The operations by the anterior route seek to fix the cartilage in a normal position and curvature at once, so that no cicatricial contraction is possible to destroy the effect of the surgeon's skill.

The device of attacking the tarsal cartilage from the anterior surface is apparently owed to Streatfield (22), of whose method a short description is to be found in the *Moorfields Reports*, vol. ii.

The operation is in all essentials that usually described as Snellen's, with the exception that Streatfield recommended that the strip of skin and muscle overlying the excised segment of cartilage should be removed with the latter, and that no stitches should be put in. He thought that the cicatricial contraction of the tissues would be more able to cause the required eversion of the lower margin if the wound healed slowly.

Streatfield's Operation

Instruments.—Desmarres' forceps (Snellen's clamp would be now substituted), scalpel, dissecting forceps.

First Stage.—The lid being held in the clamp, the surgeon makes an incision through skin and muscle, just above the roots of the lashes; this incision is deepened until it reaches the tarsal cartilage. A second incision is made about 2 or 3 mm. above this, joining it at the extremities, and, like the former, extending in the whole width of the lid, through the overlying tissues, to the tarsal plate.

Second Stage.—The incisions are then carried into the tarsal plate, obliquely, so that they join one another at or near the posterior surface of this structure, but do not interfere with the conjunctiva.

Third Stage.—All the tissues between the two incisions are removed, and the wound left to close by granulation.

It will be seen, on comparison with the method of Snellen, which is described below, how close is the resemblance of the two operations.

Snellen's Operation

Snellen modified Streatfield's operation as follows.

The same instruments are needed.

First Stage.—The surgeon makes an incision in the whole length of the tarsal cartilage (about 5 mm. above the lid margin, so as to be above the hair follicles) through skin and orbicularis, and by a slight dissection lays bare the tarsal plate at the region where the bending is most marked.

Second Stage.—He then makes two incisions through the tarsal cartilage, from end to end; these incisions are about two millimetres apart on the surface, but are directed towards one another, in the substance of the tarsus, so as to include a prismatic strip with the apex of the prism at the conjunctiva. This strip is excised with great care, so as to avoid any perforation of the conjunctiva. After its removal the tarsal cartilage is in two

pieces, and the lower part is connected with the upper only by means of the conjunctiva.

Third Stage.—The surgeon now passes the sutures thus: taking a curved needle, he introduces it above the wound through skin and subjacent tissues, and through the tarsal cartilage, making it appear at the cut edge of this last. Then he passes the needle downwards and backwards through the lower fragment of the cartilage, so that it emerges on the conjunctiva, just behind the lid margin. Three such sutures are usually sufficient. When they are tied, the lower segment bearing the lashes is rotated on its own transverse axis, through an angle

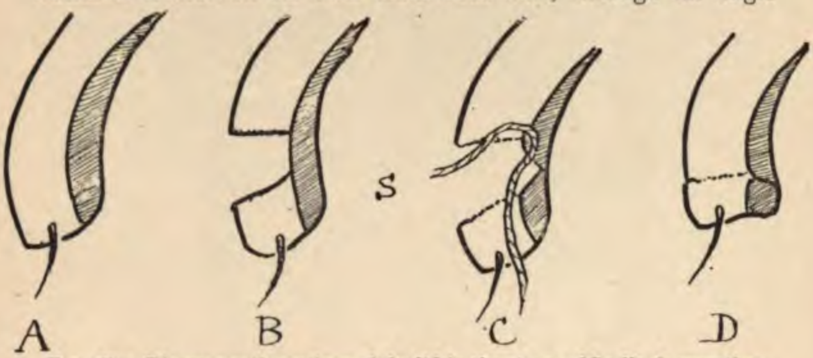

FIG. 57.—Diagrammatic sections of the lid in the stages of Snellen's operation.

equal to the apical angle of the prism excised, and the lashes, instead of pointing downwards, point forwards.

(Snellen advises a different mode of inserting the sutures; he passes the needle at once into the anterior surface of the tarsus without piercing the skin of the upper segment, and after bringing it out at the cut section, passes it onwards through the lower segment, in the cellular interval between the orbicularis and the tarsus to the grey line where it emerges. The ends are tied, left long, and secured to the forehead. The path described in the text seems more simple, and equally efficacious.)

Knapp's Operation

Knapp's operation is very similar to this, and the first stage is identical.

Second Stage.—The surgeon makes two incisions parallel to each other and about 2 mm. apart, at right angles to the surface of the tarsal plate and through this, taking care not to injure the subjacent conjunctiva. The intervening strip of tissue is excised, and thus a gap of some breadth is left between the parts of the tarsus.

Third Stage.—Now taking a curved needle, the surgeon passes it through the skin above the wound and through the tarsal cartilage, to the cut border. Thence he passes it almost horizontally backwards through the lower segment of the lid, emerging on the conjunctival surface.

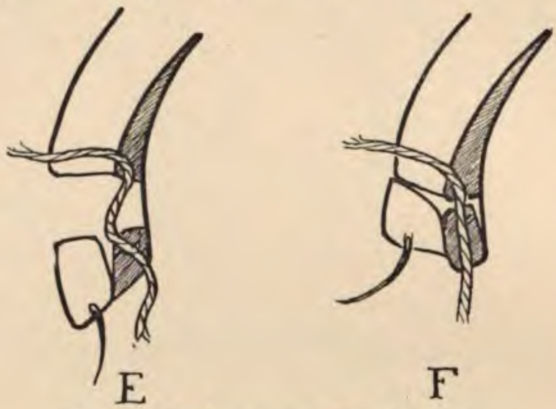

FIG. 58.—The last stages in Knapp's operation.

As in the preceding operation, three sutures are sufficient.

When they are tied the lower segment is rotated round its own axis through about 90°, and the hairs partake in this rotation.

A slight degree of shortening necessarily follows this operation, but is not wholly disadvantageous; trachoma is almost always combined with slight ptosis, as a result of the thickening and increase of weight of the affected lid, and this secondary deformity is remedied by the shortening.

We have never met with a case which could not be dealt with in a satisfactory manner by means of one of these latter operations. The trachoma commonly seen in London is

mild in type. In Australia the disease is much more severe, and surgeons there have had to adopt an operation which combines all the principles which have been mentioned.

Barrett and Orr's Operation (23)

First Stage.—The surgeon makes an incision along the whole length of the lid, just above the hair follicles, through skin and subcutaneous tissues down to the tarsus. By a slight dissection the anterior surface of the tarsus is exposed.

Second Stage.—If the tarsus is much incurved, a prism-shaped piece is excised, as in Snellen's operation. In most cases, apparently, this stage is omitted.

Third Stage.—By means of gut sutures the surgeon secures the edge of the skin bearing the lashes to the upper part of the tarsal plate. Three such sutures are sufficient. The tension of the sutures everts the lashes. The skin wound is closed with horse hair.

Fourth Stage.—A second incision is made in the grey line behind the roots of the cilia. This allows them to slide up somewhat on the tarsal plate, and lifts them still further out of the dangerous position at the lid margin.

Fifth Stage (Orr's modification).—The posterior layer of the lid, the tarsus, is sutured down to the upper margin of the lower lid by gut sutures, so that the tarsus is dragged downwards.

The experience of these surgeons is so great in this matter that we have much hesitation in criticising their methods; it seems to us, however, that the raw surface left at the lid margin in this procedure is a disadvantage, and that with a constant excision of a prismatic section it might be found unnecessary to make the incision in the grey line.

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CHAPTER IV

OPERATIONS ON THE LIDS—*continued*

Ectropion

Ectropion—eversion of the lid—is due to one or other of several causes, to paralysis of the orbicularis, to displacement of the lid by some swelling, innocent or malignant, or to cicatricial contraction of the surrounding parts.

Paresis, or paralysis, of the orbicularis is one of the most important causes of ectropion of the lower lid. In Bell's paralysis the loss of tone of the muscle allows the lid to fall away from the globe, and to expose the inner conjunctival surface to a greater or less extent. Between the lid and the globe there is left a large space in which tears collect: when it is full, the tears cannot reach the puncta lacrymalia, and run over the face, causing discomfort and often giving rise to eczema. Nor is this all; the lower part of the cornea is exposed to injury from the absence of the normal protection, and, after a time, often becomes ulcerated and nebulous. Usually the tendency of the paralysis is to recovery, and we should not be eager to undertake surgical interference; but if, after reasonable waiting, the symptoms still continue, something must be done. If the recovery have been nearly complete, it will be sufficient to make easier the outflow of the tears. This will prevent further lacrymation, which is the chief discomfort.

Our object is easily attained by incising the lower canaliculus on the inner surface of the lid in such a way that it is

converted into an open gutter, down which tears can easily escape from the lacus lacrymalis into the sac. The little operation will be described later.

Should the ectropion be rather more, sutures may be inserted to correct it.

Snellen's (1) Sutures for Ectropion

The surgeon takes a stout silk thread, armed at each end with a needle, and passes one needle through the most prominent part of the everted conjunctiva and underlying tarsal cartilage, thence onward subcutaneously to the lowest fold of the lid. The fellow needle is passed in a similar course about 8 mm. away from the first. One such suture is required at each extremity of the middle third of the lid. When the ends are drawn taut, and tied over a piece of drainage tube, the lid is pulled back into a normal position. The sutures should remain *in situ* for at least a week.

These methods of treatment are only of avail in very slight degrees; if the sutures fail, the lid may often be drawn back into position by cauterising the internal surface with the galvano-cautery; the point must be drawn along the whole length of the lid near the margin. The contraction of the small scar corrects slight displacement.

If these measures prove insufficient, or if the deformity is from the first clearly more than such means can correct, a more drastic procedure must be used. It must be borne in mind that continued eversion lengthens the lid margin. Any operation for its remedy must therefore shorten it to its former length. Various methods for shortening and raising the lid have been proposed. Of these one of the best is that devised by Kuhnt (2).

Kuhnt's Operation

Instruments.—Scalpel, or lance knife, dissecting forceps, needles and needle-holder.

First Stage.—The surgeon estimates the amount of shortening necessary to replace the lid, and marks out on the conjunctival

surface a triangle, whose base at the lid margin is equal to this amount, and whose apex is just below the lower border of the tarsal cartilage. The lateral incisions pass through both conjunctiva and tarsus.

Second Stage.—The operator makes an incision in the grey line along the base of the triangle, and removes that part of the tarsal plate and conjunctiva within the area delineated, leaving the superjacent tissues intact.

Third Stage.—The margins of the wound are brought together by several sutures passed from the skin surface, which must have a firm hold on the tarsal cartilage. One should be placed near the margin of the lid, and care must be taken to keep the two parts of the tarsus in line, so as to preserve the line of the lid smooth and even.

FIG. 59.—Kuhnt's operation. *Second stage.*

The immediate result is to produce an ugly fold of skin opposite the wound, but this soon disappears. The only danger is that the sutures are not sufficiently firmly placed; unless they are secure, they may cut out and allow the wound to gape and the deformity to reappear.

In this operation the redundant skin and muscle are left unattacked. Dimmer (3) describes a modification of Kuhnt's operation, which is designed to avoid this defect.

Dimmer's Operation

First Stage.—Having estimated the amount to which the surgeon desires to shorten the lid, he makes an incision of that length, just external to the external canthus and in the same horizontal line, through the skin; from each end of this he makes another downwards, so that the three enclose an isosceles triangle; the skin within this triangle is excised.

Second Stage.—From the outer canthus inwards he then splits the lid by an incision in the grey line, until he has passed the middle of the margin.

Third Stage.—Next the surgeon excises a triangle of tarsal

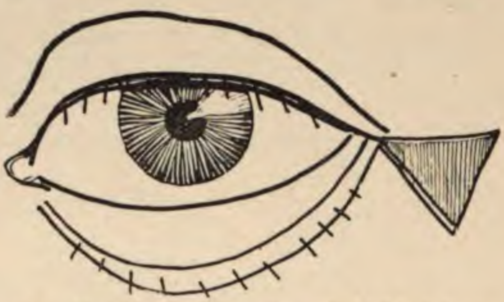

FIG. 60.—Dimmer's operation. *End of first stage.*

cartilage equal in size to the triangle of skin which was removed in the first stage, and with it, necessarily, the conjunctiva to the same amount. The excised triangle has its base at the

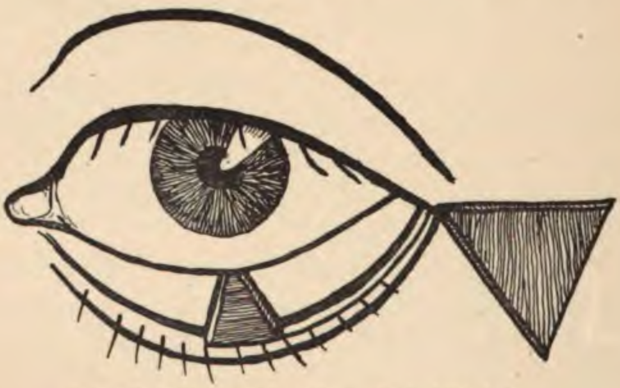

FIG. 61.—Dimmer's operation. *End of third stage.*

lid margin, and its inner border corresponds with the inner extremity of the splitting of the lid.

Fourth Stage.—The marginal skin with its hair follicles is removed from the lid near the external canthus, and the whole lid is drawn outwards, so that the gap in the tarsal plate is closed and the external triangle is covered by the skin of the

lid. The parts are secured in the new position. The skin must be united first, and afterwards deep sutures must be passed to hold the edges of the tarsus together.

Tweedy has described an operation for shortening and raising the lid; although it was intended for the relief of certain cases

FIG. 62.—Dimmer's operation. *Final stage.*

of cicatricial ectropion, it may be used with advantage in some severe paralytic forms.

It will be described, however, under the head of cicatricial ectropion, for which the author designed it.

SENILE ECTROPION

In old people persistent blepharo-conjunctivitis often gives rise to a very unsightly form of ectropion. The marginal conjunctiva is thickened and everted as a prominent red fold. The heavy tissues overtax the orbicularis and the lid falls away from the globe.

The muscle is not really weakened, and, at all events in the early stages, the tone can be restored if the conjunctiva become again normal. Astringents are occasionally able to cure the deformity; more commonly, unfortunately, the disease of the lid is of such standing that it is not amenable to such mild forms of treatment. Under these circumstances the surgeon will have to consider the best means to relieve the defect.

The application of the galvano-cautery to the everted conjunctiva, either in one line along the whole length of the lid, or preferably in three or four short lines across the fold, will give

rise to a slight degree of cicatricial contraction sufficient to roll in again the margin to its normal position.

In the worst forms, however, this does not suffice, and some more extensive procedure must be adopted.

In such cases as we are considering, the surgeon will find, if he examines the lid, that the conjunctiva is almost healthy near the cul-de-sac, while the marginal portion, perhaps rather more than half, is thickened, reddened, and everted: this is the diseased area.

Freeland Fergus's Operation

Freeland Fergus (4) recommends excision of the affected part.

Instruments.—Scalpel, scissors, dissecting forceps, needles and needle-holder.

First Stage.—The surgeon makes two incisions, enclosing the diseased fold from end to end of the lid; the outer incision is placed at the junction of the conjunctiva and skin, and the lower at the junction of the healthy and diseased area.

Second Stage.—He picks up the lip of the healthy conjunctiva below the lower incision, and dissects up the mucous membrane to the cul-de-sac.

Third Stage.—He then excises rapidly the diseased tissues, and closes the wound left after their removal by several points of suture.

In this way the lower healthy conjunctiva is brought up to the skin and forms a new margin to the lid. Fergus states that it is rarely if ever necessary to shorten the lid or deal with the skin in any way.

Terson's Operation

Terson (5), in similar cases, has not found the excision of the conjunctiva adequate. He combines with it removal of a small area of skin, and thus has devised an operation which deals efficiently with these severe forms.

Instruments.—Scalpel, scissors, fixation and dissecting forceps, needles and needle-holder.

First Stage.—The surgeon ablates the hypertrophied mass of the conjunctiva, taking care to leave the tarsus untouched. If the excision be made too deep, he will run a great risk of causing symblepharon or trichiasis.

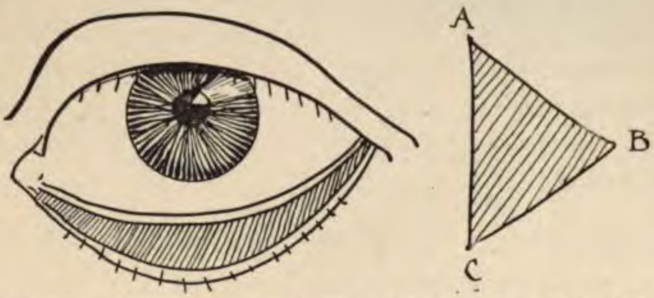

FIG. 63.—Terson's operation. *Second stage*: the shaded triangle A, B, C represents the skin removed. The shaded area on the lid shows the raw surface left after removal of the hypertrophied conjunctiva.

No conjunctival sutures are to be put in; the wound heals with less ease and regularity if any have been inserted.

Second Stage.—He now marks out, just external to the outer

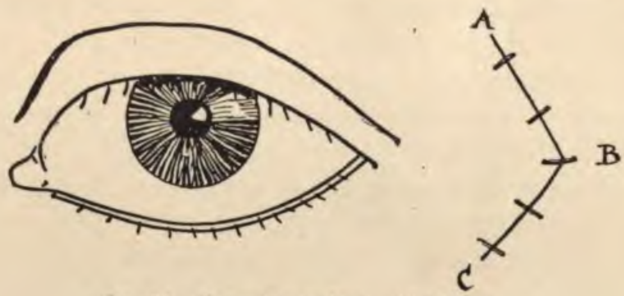

FIG. 64.—Terson's operation. *Final stage.*

canthus, a triangle of skin, having one side vertical, divided equally by the line of the palpebral fissure, and the apex external.

The size and position of this triangle is shown clearly in the diagram. The area of skin within the triangle is removed.

Third Stage.—The raw surface is covered by drawing the surrounding parts together and securing them in their new position by several points of suture.

The tension on the lower lid overcomes the eversion. The whole procedure is short, lasting only about five minutes, and is therefore well adapted to the requirements; prolonged anæsthesia is always undesirable in old people, and it may be dispensed with, if necessary, for so short a proceeding.

When the hypertrophy of the conjunctiva is small, none of this membrane needs excision; the form and position of the triangle of skin may be altered with advantage; it should be placed higher and somewhat obliquely. This modification is owed to Obarrio.

The Treatment of Cicatricial Ectropion: Blepharo-plasty

The treatment for cicatricial ectropion is to a large extent similar to that required for the reconstruction of a lid after the removal of a malignant growth, and operations for the two conditions are often grouped together under one name—blepharo-plasty.

There are two main groups of these operations, which will have to be dealt with separately, and each of these is subdivided into several minor divisions. The chief point of distinction is the origin of the new lid; in some this is made from the neighbouring parts; in others the gap left after reposition of the affected lid is filled by grafts taken from a distance.

It is not easy to estimate the relative value of these methods accurately and fairly: on the one hand certain surgeons condemn absolutely the employment of Thiersch grafts; on the other, we find some well-known authorities who express the opinion that no other method or material is so suitable for the relief of these deformities.

The point, therefore, must be left undecided. Our own experience would be in favour of using the neighbouring parts as far as is possible, and where this tissue is unavailable, of using Thiersch grafts.

Hotz (6), in the *American Journal of Ophthalmology* for 1903, describes, at some length, his procedure for the relief of cicatricial ectropion, and gives reasons for his method. There

are, he says, three points in these operations which are usually insufficiently regarded: the proper division and fixation of the flaps; the choice of suitable material from which they are to be cut; and, lastly, the shortening of the everted lid margin.

It is useless, he says, to cover a large raw area with a simple skin graft. The contraction of the graft will, in all probability, cause a second eversion within a very few months. The surgeon must therefore employ two flaps, fixing one to the lid in such a way that the contraction of the other cannot bring any pull to bear on the lid margin. The raw surface, therefore, must be covered by two flaps—one for the lid and one for the neighbouring area.

As to the tissue from which the flap for the lid is to be taken, nothing is so suitable, says Hotz, as the cicatricial skin; this is thin, hairless, and supple, and is almost always available.

Adjemian (7), in the xxi. vol. of the *Archives d'Ophtalmologie*, gives, as the result of many years' experience at Constantinople, his opinion that Thiersch grafts are applicable to all cases of ectropion due to cicatricial contraction, but at the same time lays down certain rules which it is essential to observe. They are seven in number.

1. The relaxation of the everted lid must be complete.
2. All cicatricial bands must be excised from the area which is to form the bed for the flap.
3. This bed must be enlarged as much as possible by traction through sutures, passed through the lid margin and secured to the neighbouring parts by collodion.
4. The flap used to cover the surface must, if possible, be single; a mosaic of flaps or grafts is doomed to failure.
5. Great care must be taken to avoid bruising the flap while it is being cut.
6. The edges must be very accurately adjusted, and care must be taken to prevent their rolling in.
7. The first dressing should be left undisturbed for six days, to allow immediate union.

Not all surgeons have found these plans of service. Dupuy-

Dutemps, for example (*Archives d'Ophtalmologie*, vol. xxi.), considers that the transplanted graft has been a failure in these operations, and expresses his preference for a modification of Fricke's operation, which he describes. The modification is only in the region from which the skin flap is to be taken. Dutemps advises the surgeon to take a fold of skin from the upper lid, which is usually redundant, to fill any gap in the lower.

Cirincione and his pupil Calderaro (8) also have found Thiersch grafts unsatisfactory, and are inclined to counsel their entire abandonment. They have come to the conclusion (*La Clinica Oculistica*, 1905) that some modification of Fricke's operation is the best where it can be carried out.

Valude expresses a similar opinion.

As a general rule, it is advisable to unite the margins of the lids (tarsorrhaphy), to oppose the contraction of the lids during the later stages of healing, which would otherwise reproduce the deformity.

Operations for Ectropion

A. By flaps from neighbouring parts.
- 1. By pedunculated flaps.
- 2. By displacement of surrounding parts.
  - (*a*) Superficial (Wharton Jones, Dieffenbach, Burow).
  - (*b*) Deep (de Vincentiis).

B. By grafts from a distance.
- 1. Containing all parts of the skin.
  - (*a*) Pedunculated. Tagliacotian operation.
  - (*b*) Wolff's grafts.
- 2. Epidermic or Thiersch grafts.

Group A, 1.—*Pedunculated flaps.*—When the deformity to be corrected is small, and the localised loss of tissue not extensive, the method of pedunculated flaps is usually successful. The surgeon will have to note certain points in the procedure which are of importance in gaining the best result. The position of

the flap must be selected in normal or approximately normal skin; if the vessels are few the nutrition of the transplanted skin is small, and it may be insufficient to tide the flap over the first twenty-four hours, before the vascular supply from the bed is able to nourish the tissue. The flap must therefore be cut so that the general flow of blood is from the base towards the extremity, and the base must be placed so that the turning necessary to place the flap in its new bed is not so great as to interfere with the vascular supply.

The surgeon must recollect, further, that the flap will undergo considerable contraction after it has been separated; it must therefore be larger by about one-third linear measurement, *i.e.* nearly double the area of the space to be filled. The base of the flap should contain the subcutaneous tissues, but the body may be advantageously formed of skin only.

The direction in which contraction will take place must also be taken into account, and utilised to prevent a recurrence of the deformity. Thus, if the upper lid be under treatment, the base of the flap will be placed below the canthus and the force of contraction thus used to prevent a second ectropion. If, on the other hand, the lower lid is under repair, the base of the flap will be upwards above the canthus.

The type of this form of operation is the original method of Fricke; many minor varieties have been described by Hasner, Dupuy-Dutemps, and others, but the main principle is that of Fricke, and the variations are simply local.

Fricke's Operation (9)

Instruments.—Scalpel, dissecting forceps, scissors, pressure forceps, needles and needle-holder.

First Stage.—The retracted lid is freed by an incision through the scar, or, if this is well localised, the whole scar may be circumscribed by two hemielliptical incisions, and removed. The margin of the affected lid must be stretched away from the attached border, so that the wound is made as large as possible.

Any deep bands of scar tissue should be excised as completely as the surgeon can, and all bleeding stopped.

Second Stage.—The flap for transplantation must next be marked out; its position will vary with the defect to be corrected. Fricke described his operation for the relief of ectropion of the upper lid, and we will follow here his original description.

The surgeon makes two incisions on the skin of the temporal region, containing between them an elongated pedunculated flap, larger in each dimension by one-third than the space to be filled. The inner (or anterior) incision should join the

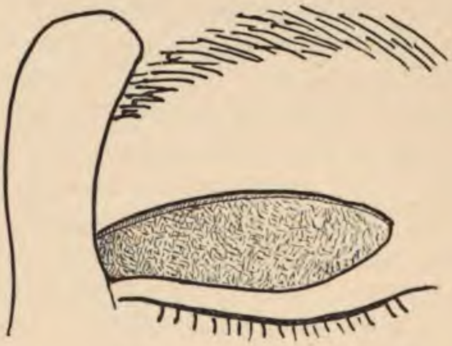

FIG. 65.—Fricke's operation. *Second stage.*

primary relaxing incision, or this latter must be prolonged to meet it. The upper ends of the two incisions are rounded into each other; the lower ends diverge slightly and are continued below the level of the canthus, the outer rather further than the inner so as to allow rotation of the flap on its base with the greatest ease.

Third Stage.—This flap is now to be dissected up; the body should contain skin only, but as the surgeon approaches the pedicle he will be well advised to take up the subcutaneous tissues also. All bleeding must be stopped.

Fourth Stage.—The flap is twisted on its base and secured into the gaping wound of the lid.

Some surgeons make a considerable interval between the first and second stages; not content with waiting until the bleeding is stopped, they wait twenty-four hours before applying the flap to its bed ; some even wait until the bed is covered with granulations. This seems unnecessary; it is enough to make sure that there shall be no effusion of blood or serum to separate the flap from its new attachments.

Dupuy-Dutemps has described a modification; to repair

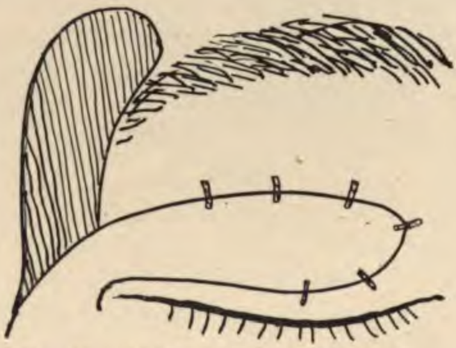

FIG. 66.—Fricke's operation. *Fourth stage.*

a defect of a lower lid, he cut a flap like that of Fricke from the loose skin of the upper.

Tweedy's operation (10), which has been already mentioned under the head of senile ectropion, may also be regarded as, in some sense, a modification of Fricke's.

Tweedy's Operation

Instruments.—Scalpel, scissors, dissecting forceps, needles and needle-holder; pressure forceps may be added, but are not often required.

First Stage.—The surgeon makes an incision downwards and outwards from the outer canthus, following the normal lines of the skin, about 30 mm. in length. He then makes a second incision about 8 mm. away from the first, starting at the border of the lid, and taking a course parallel to the first.

Second Stage.—He then makes an incision through the conjunctiva and tarsus, starting at the upper extremity of each of the two previous incisions and converging to the lower cul-de-sac. All the mass of tissue between these incisions is

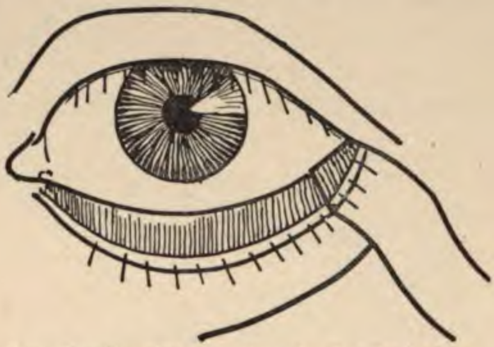

FIG. 67.—Tweedy's operation, showing the incisions.

dissected up to form a flap, adherent only by its base at the lower and outer end. The pedicle is cut long as described, to allow of the twisting which is to follow. The conjunctiva may be dissected up and used to lengthen the flap if necessary.

FIG. 68.—Tweedy's operation. Transposition of the flap.

Third Stage.—From about the middle of the lower limiting incision of the flap a third incision is made, through skin and orbicularis, down to the orbital fascia, so that the lid can be raised into place. Into the gap thus left the flap is turned and implanted; all parts are secured by stitches.

A method essentially similar to that of Fricke is that of Businelli and Badal. These surgeons suggest that a small defect of the lid may be filled by taking a bridge flap. Badal fills a gap in the lower from the upper lid, Businelli takes a flap from above the brow to repair the upper. It is practically a double Fricke flap united to its fellow in the centre.

Goyanes (11) has recently made an ingenious suggestion for those cases where the eyebrow is destroyed by scar as well as the upper eyelid. He cuts a flap from the forehead of the opposite side, taking in the upper half of the opposite eyebrow, with a long pedicle over the base of the nose.

The eyelid is replaced in position by dissection and the flap brought across to fill up the gap. The secondary loss is covered by bringing down the frontal skin.

Denonvilliers (12) proposed to raise the external angle of the eye, when this was drawn down and everted, by a procedure which he termed the substitution of flaps. The operation is limited in range, but in favourable subjects is most efficient.

Denonvilliers' Operation

Instruments.—Scalpel, dissecting forceps, pressure forceps, needles and needle-holder.

First Stage.—The surgeon makes an almost horizontal incision below the everted outer half of the lid, and carries it on to a point about 12 mm. below and external to the canthus. From this point he makes a second curved incision upwards, which reaches the brow about opposite the canthus. In this way he marks out a triangular flap, with the base towards the eye and the apex towards the temple.

Second Stage.—From the point where the first flap touches the brow, he makes a third incision downwards and outwards, which ends at a point opposite to and about 2 cm. from the external canthus. This incision, with the upper incision of the first flap, marks out a second flap placed in the reverse direction.

Third Stage.—Both these flaps are dissected up, so as to mobilise them, and they are then transposed and fixed in

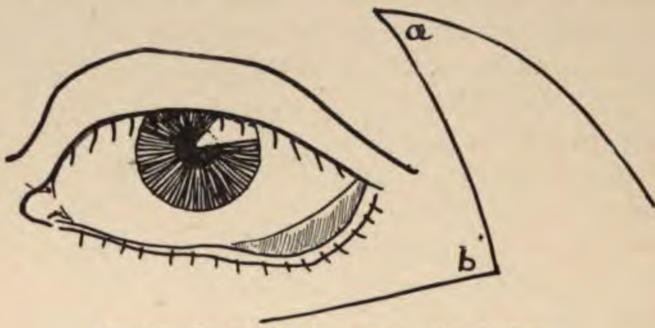

FIG. 69.—Denonvilliers' operation. *Second stage.*

position by numerous stitches. A total tarsorrhaphy will usually be required.

Richet (13) has modified this operation so as to give it greater

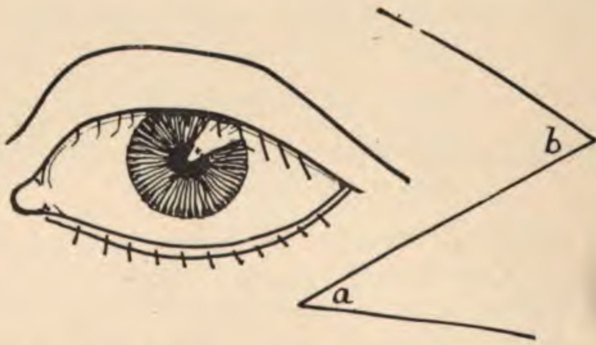

FIG. 70.—Denonvilliers' operation. *Third stage*: flaps transposed.

scope. It is still only applicable to cases of ectropion affecting the outer canthus only.

Richet's Operation

First Stage.—The surgeon makes an incision round the everted canthus, and, by dissection, frees the lid from the scar

tissue which holds it. This leaves a raw area of an irregular meniscoid shape.

Second Stage.—Having thus replaced the canthus into its

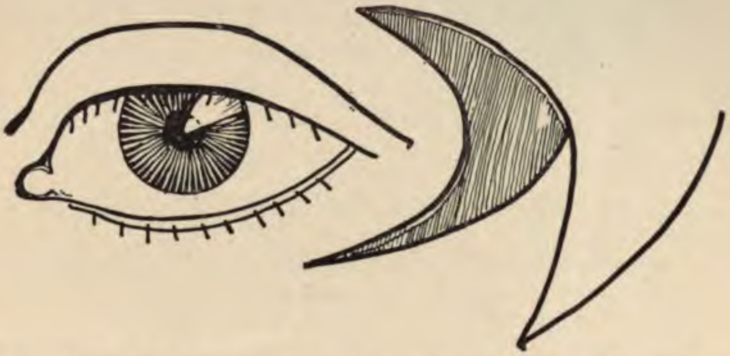

FIG. 71.—Richet's operation. *Third stage*: the eye is represented open, but would usually have been closed by tarsorrhaphy.

normal position, the surgeon sews the lids together, performing total tarsorrhaphy.

Third Stage.—From the external angle of the raw surface the surgeon makes a second incision, passing downwards and

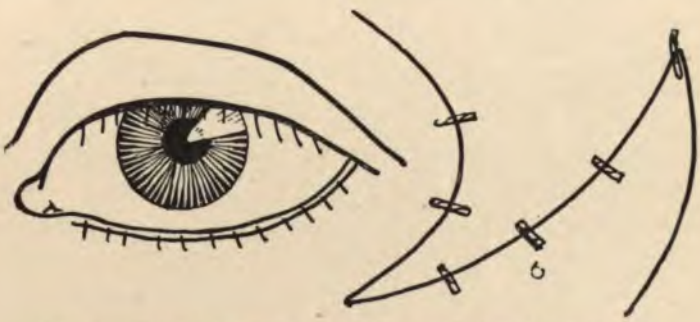

FIG. 72.—Richet's operation. *Final stage*: (without tarsorrhaphy).

outwards for about 2 cm., and from the middle of this a third, which passes upwards and outwards. These two incisions limit two triangular flaps, which must now be raised.

Fourth Stage.—The upper of the flaps is turned inwards to

fill the gap left by the dissection in the first stage; the secondary gap is filled by the larger lower flap.

GROUP A, 2 (*a*).—The operations "by sliding" are rarely satisfactory except when the defect to be filled is small. If there is a localised contraction from a scar on the face below the lid, it may be possible to remedy the deformity by means of Wharton Jones' (14) (or the V Y) operation.

Wharton Jones' Operation

Instruments.—Scalpel, dissecting forceps, scissors, needles and needle-holder.

First Stage.—The surgeon makes two incisions, one from each end of the lid, following, as far as possible, the lines of

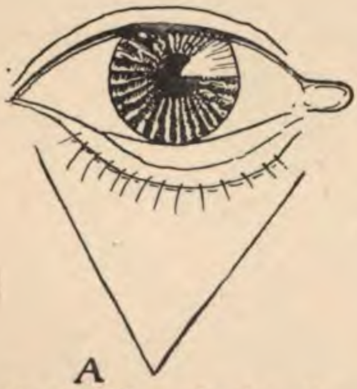

FIG. 73.—Wharton Jones' operation. *First stage.*

FIG. 74.—Wharton Jones' operation. *End of second stage.*

the skin folds, and converging to a point below the scar. The incisions include the scar.

Second Stage.—He then dissects up the contained skin freely, until the lid can be replaced easily in its proper position. All

obvious bands of scar should be excised from the subcutaneous tissue. When the lid is pushed up into place a raw surface is left below the apex of the V.

Third Stage. — The lateral parts are now brought together and secured so as to cover this raw surface; the resulting scar is Y-shaped.

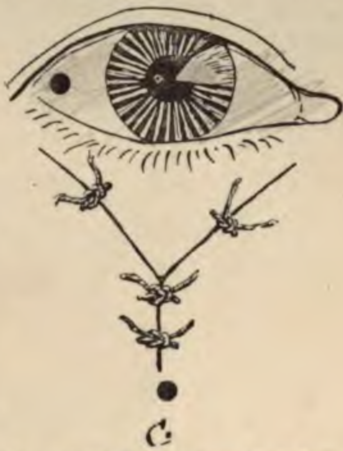

FIG. 75.—Wharton Jones' operation. *End of operation.*

Unless the defect for which the operation is undertaken be very small, it is advisable to scarify the edges of the lids and unite them temporarily. The palpebral fissure may be opened again in a few weeks.

When a considerable part of the lower lid is invaded by a new growth, or destroyed by scarring, a more extensive sliding operation was recommended by Dieffenbach (15).

Dieffenbach's Operation

Instruments.—Scalpel, dissecting forceps, scissors, pressure forceps, needles and needle-holder.

First Stage.—The surgeon marks out, on the lid, a triangular area having the base at the margin, and enclosing all the new growth or scar within the three sides. If the conjunctiva be unaffected—and this is an essential for the perfect success of the operation—the overlying diseased tissues are carefully dissected away, leaving the mucous membrane.

Second Stage.—The surgeon then marks out on the face, on the outer side of the raw area, an oblique parallelogram, having as one side the external side of the triangle, and another bounded by an incision prolonging horizontally the base of the triangle, and of equal length. A third side is parallel to the first, and the fourth is left continuous with the cheek.

This parallelogram of skin is dissected up.

Third Stage.—It is then slid over and secured so as to fill the triangle; it necessarily leaves an area equal to the original triangle uncovered on the cheek, and this is left to granulate.

If the operation were performed at the present time, the raw surface would probably be covered by grafts.

Burow's Modification

Burow attempted to improve the operation in the following way:—Having excised the tissues from the triangle, as in

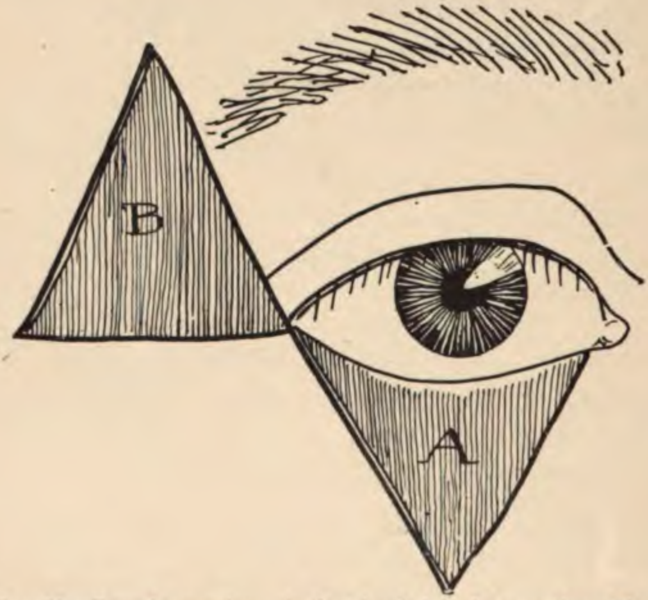

FIG. 76.—Burow's operation. A, the triangle left after exsection of the disease; B, the secondary triangle.

Dieffenbach's method, he made an incision outwards from the outer canthus of equal length with the base of the triangle, and on this as a base, marked out a second triangle equal to the first with the apex upwards. He then excised the skin within this second triangle. Lastly, having loosened the parts, he slid the skin over so as to cover both defects.

The diagrams make the method clear.

Neither of these operations is free from very grave objections. The flap, which takes the place of the lid, will contract to a considerable degree, and there is no allowance made for such contraction.

Burow's operation removes a large piece of healthy skin from

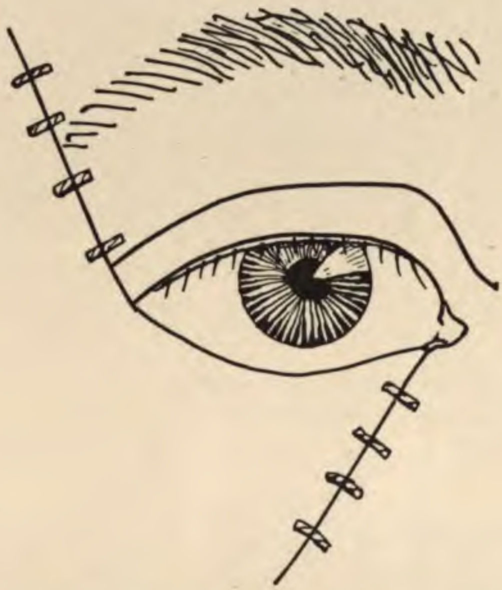

FIG. 77.—Burow's operation. The parts slid to cover the defects.

a part which already has too little. These operations are rarely if ever performed at the present time.

GROUP A, 2 (*b*).—The operation of De Vincentiis (16) is of more value, but is limited in application to new growths affecting not more than the inner third of the lid.

De Vincentiis' Operation

Instruments.—Curved, blunt-pointed scissors, scalpel, dissecting forceps, pressure forceps, needles and needle-holder.

First Stage.—The surgeon excises with knife or scissors all the part affected.

Second Stage.—He then prolongs the palpebral fissure out-

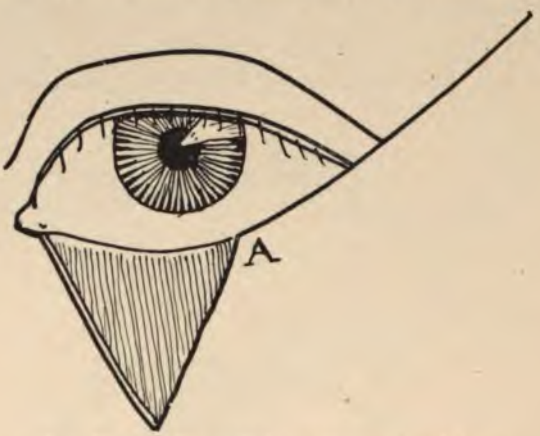

FIG. 78.—De Vincentiis' operation. *Second stage.*

wards, directing his incision a little upwards, for about 20 mm., and frees the outer part of the lid, by dividing, subcutaneously, the orbital ligament with scissors.

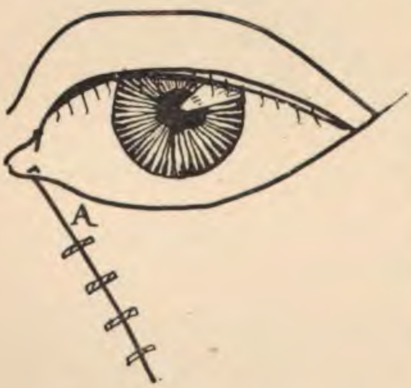

FIG. 79.—De Vincentiis' operation. *Final stage.*

Third Stage.—Then the remainder of the lid is brought along to fill in the gap, and is secured in the new position.

This method is said to be very satisfactory in properly selected cases.

It seems not improbable that in cases of malignant disease these operations will be superseded by the use of radium, which has already proved of great value; when successful, it has the great advantage over all surgical interference that it involves no loss of tissue. In

any operation it is necessary to cut wide of the disease, and thus the gap to be filled is larger than the neoplasm.

Group B.—The wound closed by grafts from a distance.

1. By flaps containing all parts of the skin.

(*a*) By a pedunculated flap. The Tagliacotian Operation.

In this method the new lid is taken from the skin on the inner side of the upper arm. The arm and head are held motionless in position during the first stages of healing, by means of a special, somewhat complicated, apparatus. The method is rarely employed.

(*b*) By Wolffian grafts.

The use of Wolffian grafts gives us one of the readiest methods of dealing with the deformities of which we are here treating. The contraction, however, of these islands of separated skin is so great that their use is more limited than would at first appear. There is no special difficulty in their employment; if all subcutaneous tissue is removed from the flap, it unites with readiness to the bed, and since its nutrition is supplied from the deep surface and not from the margins, the size of the graft has little importance.

The contraction, however, is very disturbing; grafts may lose as much as three-quarters of their original area. The method is, therefore, chiefly applicable to the upper lid, where the tarsal plate resists contraction.

2. The wound is closed by Thiersch grafts (epidermis grafts).

The value of Thiersch grafts in these cases is very variously estimated by different surgeons. Calderaro, in a recent valuable study of the various operations of blepharo-plasty (*La Clinica Oculistica*, April 1905), lays down the rule that their use should be abandoned and that such grafts should be banished from ophthalmic surgery. Hotz, as we have already pointed out, is of an absolutely opposite opinion. His method of operation has several points of difference from that of most surgeons, and therefore deserves detailed attention.

Hotz' Operation

Instruments.—Scalpel, dissecting forceps, scissors, pressure forceps, needles and needle-holder.

The steps will vary a little with the condition of the skin of the eyebrow. If the hairs are numerous, the skin cannot be used to make a new lid.

If, on the contrary, the brow have suffered in the cicatrisation, the skin to cover the upper lid may be taken from it.

First Stage.—A large incision is made through the skin above the lid margin, beginning about 3 mm. above and outside the outer canthus, passing upwards in a curve to the brow and then descending in a curve to a corresponding point near the inner canthus. The large flap thus marked out is dissected up, and all cicatricial bands are cut until the lid can easily be replaced into its normal position. All bleeding must be stopped.

Second Stage.—The lid is stretched downwards by means of two or three sutures, which are passed through the lid margin and fixed down to the cheek by means of collodion.

Third Stage.—The flap of cicatricial skin is then fixed firmly to its bed by means of sutures which attach its upper border to the upper edge of the tarsus. This leaves a large elliptical raw area uncovered.

Fourth Stage.—The surgeon cuts with the razor a large Thiersch graft from the flexor surface of the forearm, of sufficient size to cover the whole raw surface, and places it in position, the edges overlapping the surrounding skin. No sutures are applied.

If, however, the presence of the eyebrow makes it impossible to cut a new upper lid from the skin above the old margin, both the lid and the facial flap must be made by Thiersch grafts. The first stages, then, will be rather different from those just described.

First Stage.—The surgeon makes an incision along the lid just about 3 mm. above the cilia, and by free dissection

mobilises the lid, so that it can be readily replaced. The bands of cicatricial tissue are then removed as far as possible.

Second Stage.—The lid margin is pulled strongly downward by three or four sutures so as to make the gap as large as possible. The sutures are fixed to the cheek by collodion.

Third Stage.—The surgeon then cuts with the razor a Thiersch graft and adjusts it to the surface of the upper lid, fastening it with numerous points of suture to the margin of the lid on the one side and to the upper edge of the tarsal plate on the other.

Fourth Stage.—The remaining gap is filled in by a second Thiersch graft, as in the preceding description.

If the surgeon has to do with cicatricial ectropion of the lower lid, the choice of procedure is easier, because the tissues below the lid are always available for the formation of the skin flap.

Since the cartilage of the lower is thin and small, Hotz advises that this flap be sewn to the orbital fascia below the cartilage proper.

Tarsorrhaphy and Canthorrhaphy

The operation by which the lids are united along their margins for whole or part of their extent is termed tarsorrhaphy. Occasionally the union of the extreme angles is called canthorrhaphy, and the term tarsorrhaphy reserved for those instances in which the new union does not reach to the canthus; and this division is useful because it enables us to distinguish readily between a union of the lids, at, for example, the region of the puncta lacrymalia from one affecting the inner angle. Accepting this division, we may agree with Terson in classifying these operations into six groups: inner and outer canthorrhaphy (uniting extreme lateral regions and practically forming new canthi), internal and external tarsorrhaphy (uniting the parts rather nearer the middle of the lid), median tarsorrhaphy, and total tarsorrhaphy, when the whole palpebral fissure is closed.

These various degrees of union are, of course, needed for

various conditions; it has been already mentioned that total tarsorrhaphy plays an important part in the operative treatment of many cases of ectropion, the lids being united temporarily, to prevent a recurrence of the deformity during cicatrisation. The surgeon will open the fissure again some weeks after the union.

When the closure is temporary only, as in such a case, the surgeon will remove a strip as small as possible from the whole length of the post-ciliary zone of the lid margins, and unite the raw surfaces with several sutures.

This method of securing union may be employed in the formation of all varieties of tarsorrhaphy, excluding canthorrhaphy, for which it is not well adapted.

Median tarsorrhaphy is specially useful in the case of neuroparalytic keratitis; here, by preserving the cornea from the intrusion of foreign bodies, the spread of the inflammation is prevented, and the ulcer, if formed, may be induced to heal.

Similarly, in the presence of lagophthalmos, from facial paralysis, a median tarsorrhaphy may save the patient's sight.

In slight cases of paralytic ectropion, when the collection of the tears and their overflow give rise to much discomfort, an internal tarsorrhaphy uniting the lids just external to the puncta lacrymalia for the space of 3 or 4 mm. will raise the lower lid and replace the everted punctum in its normal relation to the globe. All these unions may be effected by the procedure just mentioned, limiting its size in accordance with the needs of the case.

It is easy to separate the lids again whenever it may be thought that the object of the original union is attained.

Another method of gaining the same end has been invented by Bossalino. It can be used to unite the lids in whole or part as required.

Bossalino's (17) Tarsorrhaphy

Instruments.—Scalpel, lid plate, needle and needle-holder.

First Stage.—Having decided how far the new union of the lids is to extend, the surgeon splits the upper lid from that

point to the canthus by making an incision in the grey line of the lid, thus dividing the anterior sheet, which contains the orbicularis and hair follicles, from the posterior, which consists of tarsal plate and conjunctiva. The incision is carried upwards until it is about 3 mm. deep.

Second Stage.—The lower lid is then split in the same way and to the same extent.

Third Stage.—Then taking a suture, armed at each end with a needle, the surgeon passes the needles through the posterior layer of the lower lid from the conjunctival surface, so that a loop is left on the conjunctiva ; the points of emergence should be about 4 mm. apart.

Each needle is then introduced in succession into the wound in the upper lid at a point opposite the point of emergence from the lower, and carried upwards between skin and tarsal plate for about 1 cm. At this level, *i.e.* about 14 mm. above the lid margin, both are brought out on to the skin, and tied over a piece of drainage tube.

External tarsorrhaphy is rarely needed except in conjunction with canthorrhaphy.

Occasionally it is necessary to shorten the palpebral fissure, in order that the lids may close more easily over the globe and offer better protection. In Graves' disease, for example, the protruding eye is sometimes seriously damaged because of the non-closure of the lids.

External cantho-tarsorrhaphy, as it may be called, at once hides the deformity and remedies the defect.

The operation of Fuchs (18) is suitable for these cases.

Fuchs' Operation

Instruments.—Scalpel, dissecting forceps, scissors, needles and needle-holder.

Let us suppose that the surgeon thinks it desirable to close the outer part of the fissure for a distance of one-third of an inch.

First Stage.—The surgeon makes an incision of the required length in the grey line of the upper lid, and deepens it until it reaches above the hair follicles. He then makes a second incision, about one-eighth of an inch long, vertically through the tissues of the anterior plane at the inner extremity of the first, and by a third incision unites the outer end of the first and the

FIG. 80.—Fuchs' operation. *Middle of third stage*: showing "mattress stitch."

upper end of the second incision. In this way he removes the skin and hair follicles from a small triangular surface, leaving it raw.

Second Stage.—The surgeon now splits the lower lid in the grey line to the same distance as in the case of the upper, and by a vertical incision at the inner end loosens the area of the

FIG. 81.—Fuchs' operation. *Final stage.*

skin, which, however, is left attached by its lower margin to the lid tissues.

Third Stage.—The triangle of skin is raised to fill the gap left by the removal of the skin and hair follicles from the upper lid, and is held in position by several points of suture. To secure firm and complete union, the first suture should be passed in the way known as "mattress stitch," as follows :—A silk thread is armed at each end with a needle. These are

passed from the conjunctival surface of the upper lid through the tarsal cartilage, and appear on the raw area; then through the loosened skin flap of the lower lid from behind forwards; lastly, the ends are tied over a piece of drainage tube on the surface of the skin. The marginal wound is then closed by three or four separated stitches.

Hale (19) has recently modified this procedure. The original operation does not, in his opinion, give a satisfactory canthal angle.

First Stage.—The surgeon marks on both lids the point where the new canthus is to be. From this point he makes an incision downwards in the lower lid for about 5 or 6 mm., and from the lower end of this a second curved incision to the outer canthus. From the triangle contained between these incisions and the lid margin he removes all the skin and hair follicles.

Second Stage.—He now marks out on the conjunctival surface of the upper lid an area corresponding to that on the lower, but 1 mm. larger in each direction. Here he removes all the tissues except the skin, *i.e.* hair follicles, muscle, tarsal plate, and conjunctiva.

As the result, he has now two flaps—that of the upper lid consisting of skin only, that of the lower containing all the subcutaneous parts. They are secured together as in Fuchs' operation, and the new canthus is formed.

Canthoplasty

On the other hand, it may be desirable to enlarge the palpebral fissure, *e.g.* in cases of blepharospasm. This procedure is called canthoplasty. The usual method is simple.

Instruments.—Stout scissors, needles and needle-holder. Pressure forceps may be at hand.

First Stage.—The surgeon places one blade of the scissors deeply in the commissural sac; he stretches the lids widely apart with his disengaged hand, and with a single cut of the scissors divides the commissure as far as he thinks proper.

Second Stage.—He then dissects up the conjunctiva from the region of the commissure for some distance (if this be not done, the fissure is not infrequently narrowed by recontraction) and stitches the conjunctiva to the skin of the lid by several points of suture.

Another method is that of Valude (20).

First Stage.—The surgeon picks up a vertical fold of skin outside the outer canthus, and divides it horizontally with scissors, making a wound about half an inch long.

Second Stage.—Then taking the scissors, he places one blade inside the cul-de-sac of the conjunctiva, and one in the wound and cuts first upwards and outwards, and then makes a second cut downwards and outwards, freeing the conjunctiva boldly.

Third Stage.—He then closes the skin wound by several points of suture, so as to make the wound + shaped. The point of the conjunctival flap may be united to the new commissure, if necessary.

Chalazia

These little tumours very frequently need surgical interference. Often it is enough to incise them from the conjunctival surface and evacuate their contents; sometimes the walls are thick and must be dissected out.

The marginal chalazia are specially unsatisfactory to treat. For these it is best to make an intermarginal incision and express the contents through this; such an incision has been recommended by several surgeons, as a routine for all such tumours, even though situated far from the margin.

Operations on the Conjunctiva

Symblepharon

Symblepharon is an abnormal adhesion between the lid or lids and the globe. It follows, most commonly, burns of the eye from some chemical caustic—such as lime—but may occur as a part of certain conjunctival diseases, *e.g.* pemphigus conjunctivæ. In the later conditions, which are, for the most

part, progressive, surgical interference can do little; in the former, it is sometimes possible to do much.

The lower lid is that most usually at fault; the adhesion is of importance not only because it may interfere with the power of vision, but also because it limits the movements of the globe, and the constant drag is most irksome to the patient.

There are two main forms of operation for its relief: one relies on the transplantation of flaps from the neighbouring conjunctiva, the other on the transplantation of epithelium from a distance.

The former is only applicable when there is sufficient conjunctiva uninjured to spare enough to cover the space left after dissecting the adhesion away; the latter is used when the adhesion is so extensive that the former is impossible.

Pridgin Teale's Operations for Symblepharon

Teale (21) has described two different procedures for the relief of this condition.

Instruments.—Scalpel, speculum, dissecting forceps, needles and needle-holder.

First Stage.—The surgeon makes an incision through the lid in the position of the margin of the cornea, leaving the apex of the adhesion still adherent to the eye. Then he dissects the lid freely away until the parts are as movable as in the normal state.

FIG. 82.—Teale's operation. The lid is dissected free and the covering flaps marked out.

Second Stage.—On the conjunctiva on each side of the cornea he marks out a flap, about 16 mm. long and about 6 mm. in breadth; the limiting incision on the corneal side of each is carried down to join the wound made by the first dissection.

Third Stage.—A suture is passed at each apical angle of the

flaps, and each is then raised from the globe and turned on its pedicle to assist in filling the gap. The dissection required to raise the flaps must be made very carefully to avoid any false cut which might spoil the chances of the whole. Unless the sutures are placed in position in the corners before the dissection is made, the flap will be likely to roll up, and this will prevent accurate adjustment.

FIG. 83.—Teale's operation. *Final stage*: the defect covered by the flaps.

Fourth Stage.—The secondary wounds are easily closed from their edges.

Teale's (22) Second Method

The *First Stage* of the method is similar to that of the first plan.

Second Stage.—The surgeon marks out a bridge flap of conjunctiva, arching over the cornea. The two limiting incisions should be about 6 mm. apart, and their ends must be turned somewhat outwards. The lower incision must join the dissection wound at each end.

Third Stage.—Two sutures must be inserted into each border of the bridge-flap at about the ends of the middle third, and the whole raised by dissection. The silk threads will prove a great assistance during this part of the operation, which is always very slow and difficult.

When the dissection is complete the bridge is brought down across the anterior surface of the cornea and secured into the bare area by the sutures.

Fourth Stage.—The secondary wound is covered by drawing together the conjunctiva on each side of it.

Prawossud's Operation

Prawossud (23) has described a method of dealing with this condition which seems likely to give successful results.

Instruments.—Scalpel, dissecting forceps, needles and needle-holder.

First Stage.—The surgeon makes an incision dividing the outer canthus with the scalpel, and frees the lid from the globe by dissection.

Second Stage.—From the outer end of the first incision, and from the inner canthus, he makes a vertical incision, each about 15 mm. long, through the whole thickness of the lid.

Third Stage.—These three incisions, with the lid margin, mark out a flap, which can be drawn down, exposing a large raw surface on the inner side of the lid and outer side of the globe. From this all scar tissue is excised. Then a flap of mucous membrane is fitted accurately to the raw area, being joined at the anterior edge to the skin of the lid margin, and by its posterior edge to the conjunctiva of the globe. The fornix conjunctivæ is kept in position by means of three sutures which are passed through the flap at the point selected, and carried onward through the soft parts to the skin of the cheek, below the lowest lid-fold.

Fourth Stage.—The flap is replaced in apposition with the globe, and the original incisions closed by sutures.

Hansen Grut's Operation

Hansen Grut performs a very simple operation for symblepharon, which is at the same time efficient.

Instruments.—Scalpel, razor, artificial eye or glass mask, needles and needle-holder.

First Stage.—The surgeon makes a new cul-de-sac with the scalpel.

Second Stage.—After the bleeding is stopped he cuts from the forearm a large Thiersch graft, which he applies to the border of the artificial eye, so that the epithelium is in contact with the anterior and posterior surfaces.

Third Stage.—Then the eye thus clad is placed into the new fornix and the lids secured over it by a few points of suture.

It is not necessary to scarify the edges before applying the sutures, since the lids need be closed for only a short time.

PTERYGIUM

Pterygium is the name given to the growth of a fold of conjunctiva over the cornea; it usually occurs at the inner side, and is very slow in progress. The more rapid forms are vascular and opaque, and are known as p. crassum; the slower the growth, the more transparent the conjunctiva of which it is made, p. tenue.

Since eventually the fold may spread over the pupil, and thus interfere with vision, treatment is necessary in a comparatively early stage. The cause of the disease is almost certainly chronic irritation, hence the sufferers are usually men who have been exposed to dust. Lately Sachsalber has endeavoured to prove that the inversion of downy hairs near the canthus has an important bearing on the disease: he states that by pulling out the hairs he is able to bring the growth to a standstill.

The shape of the fold is more or less regularly triangular, with the apex towards the pupil: it lies over the cornea, attached by a narrow "mesentery." Growth takes place by ulceration at the apex of the pterygium.

When a pterygium is increasing in size, it demands operative interference, since its continued growth will or may carry it across the pupil, and effectually mar the visual acuity. It is not enough, in the majority of cases, to dissect the mass back and excise it; the growth will return and require a second removal. There are several methods of treatment which are efficient; the original operation of transplantation was devised and advocated by Desmarres.

Desmarres' (24) Operation of Transplanting a Pterygium

Instruments.—Speculum, fixation forceps, scissors, needle and needle-holder.

First Stage.—The pterygium is picked up with the forceps

and dissected off the cornea and sclerotic for its whole length; since the mass is attached to the globe by a narrow band only, this dissection makes a comparatively narrow gap in the conjunctiva.

Second Stage.—From the lower border of the incision the surgeon makes a second curved incision downwards about 10 mm. long, running concentrically with the cornea, about 4 mm. from the limbus.

Third Stage.—He then dissects up the conjunctiva on the margins of this wound, and into this gap transplants the pterygium, fixing the apex into the lowest part. The conjunctival flaps are now brought over the mass and secured by two or three points of suture.

If treated in this way, the return of the pterygium is satisfactorily prevented. There is, however, a small disadvantage, in that the mass makes an irregular elevation on the side of the cornea; to lessen this deformity, Knapp (25) has proposed a slight modification of the procedure. He splits the pterygium into two parts and sutures each half separately under the conjunctiva.

Knapp's Operation

Instruments.—As for Desmarres' operation.

First Stage.—The pterygium is picked up in forceps and

FIG. 84.—Knapp's operation. *First stage*: division of the pterygium.

dissected off the globe; then, still held in the forceps, it is divided from apex to base by a horizontal incision with the scissors.

Second Stage.—From the horizontal gap left by the dissection of the pterygium, two incisions are made, one upwards and the

Fig. 85.—Knapp's operation. *Second stage*: each half is turned under the conjunctiva.

other downwards, extending about 10 mm., and the edges of the conjunctiva dissected up.

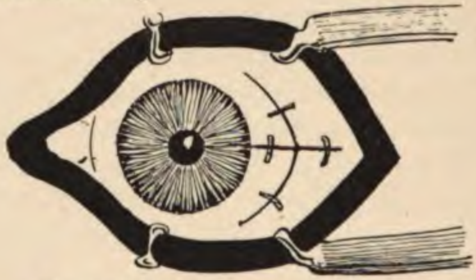

Fig. 86.—Knapp's operation. *Final stage.*

Third Stage.—Each half of the pterygium is fixed separately into one of these wounds and the conjunctiva is sutured over.

Peritomy

The operation of peritomy, though an operation on the conjunctiva, is, in its effects, an operation on the cornea, and will be found in a later chapter, where we discuss the methods of dealing with corneal opacities.

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CHAPTER V

ENUCLEATION AND ITS SUBSTITUTES

THE operations which will be described in the following chapter are such as are only undertaken on eyes which have no claim to be considered as organs of vision, but require surgical treatment, either for the relief of pain, or for the removal, in whole or part, of a damaged organ, which, allowed to remain untreated, might prove a source of danger to its possessor.

As regards the order in which they are here dealt with, it has been thought most convenient to take first the operations for complete removal of the globe, and then the substitutes for simple enucleation in "cosmetic" order, passing from optico-ciliary neurotomy and other procedures in which no tissue is removed, through partial amputations and eviscerations, to the modified enucleation operations, in which a glass ball or other body is put into the empty capsule of Tenon.

This arrangement is, perhaps, hardly logical, but the operation of enucleation is of so much importance, and demands so much consideration, that its convenience has outweighed other factors.

Removal of the eye, in some sense one of the largest, though by no means the most delicate, operations in ophthalmic surgery, is also one of those most frequently required, and one which may have to be performed by every practitioner.

The more special operations are, for the most part, entrusted to men who, by special training, are more accustomed to their performance; removal may be an urgent necessity which can allow no delay.

It is called for, not only on account of disease (such as malignant growth), which might by extension endanger the sufferer's life, but much more commonly to prevent, by removal of one inflamed and damaged organ, the possibility of the loss of the uninjured fellow by sympathetic inflammation.

The fear of sympathetic ophthalmia has, no doubt, frequently caused surgeons to excise eyes which might have recovered some, perhaps even a large, fraction of normal vision; but it cannot be doubted that it is better to sacrifice a badly damaged eye than run any great risk of total blindness, and the treatment of sympathetic ophthalmia is so uncertain, and the prognosis so bad, that we cannot wonder that many patients are pressed after injury to submit to immediate removal without any attempt to save a seriously hurt eye.

But if we are, by operation, to avert the danger of loss of both eyes, we must surely do our best endeavour to minimise the resulting deformity, and hence, despite its simplicity, simple removal is slowly but steadily losing ground as a routine operation in all cases, while one or other substitute is adopted; it is still, however, that most commonly employed.

The old operation for removal, which remained in use until about 1840, was one of the rudest imaginable. A stout silk thread was passed through the eyeball, and this drawn forcibly forward; then the surgeon took a double-edged knife, and, thrusting it into the orbit behind the eye, swept it round until all the tissues were divided and the eye free. It seems hardly necessary to add that the stump very rarely allowed the use of an artificial eye.

This barbarous method has been entirely supplanted by enucleation.

Enucleation

For the performance of this operation a general anæsthetic is necessary.

Instruments. — Speculum, fixation forceps, squint hook, strabismus scissors, large curved scissors; a pair of pressure forceps may be added, but will probably not be required.

The procedure may be considered in three stages:—

First Stage.—Opening the Capsule of Tenon.—Seizing the conjunctiva in the forceps, the surgeon divides it all round the circumference of the cornea, leaving as little of the membrane as possible adherent to the globe. He dissects the conjunctiva and subjacent capsule back slightly so as to open the space of Tenon.

Second Stage.—Division of the Recti.—The four recti muscles are picked up with the squint hook in succession, and divided with the scissors. The globe is now held only by the oblique muscles and the optic nerve, and it can be without difficulty dislocated forwards beyond the palpebral fissure. It is well to do this now, since if it is not done the surgeon may find a little difficulty in getting the globe out after division of the optic nerve.

Third Stage.—Division of the Optic Nerve and Removal of the Eye.—The large curved scissors are passed down on the inner side of the eye, and the optic nerve is felt for. It is easily recognisable as a thick rounded cord.

The blades are then opened and placed one on each side of the nerve, so that they divide it by a single cut. If it is desired to remove as much as possible of the nerve with the globe, the ends of the scissors must be pushed back along the optic nerve, towards the optic foramen. This is the reason why the scissors must be inserted at the inner side. If they are passed from the outer side, the nerve cannot be found as readily nor divided so far back. The globe now comes freely outside the orbit, and, when the obliques are cut, is free.

There is seldom any serious bleeding; a plug of gauze may be placed inside the lids, and a pad and bandage over all. Often the plug is unnecessary.

The after-treatment is simple; the plug, if one has been inserted, is removed after forty-eight hours, and the socket gently washed out. Secondary hæmorrhage is almost unknown, and the plug never, in the writers' experience, need be re-introduced. The socket should be washed out three or four

times daily; the patient may be allowed up on the third day, and will almost certainly be able to go out of hospital within the week. It is well to defer the wearing of an artificial eye for about a month. For the first fortnight a mild astringent lotion should be used several times a day.

In some cases, after the globe has been removed, the surgeon will find that he has not cut the optic nerve as far back as he wished. It is then easy to feel the end of the nerve among the orbital fat as a thick rounded cord. This may be caught in forceps, pulled forward, and redivided with the scissors.

To make the primary division easier and more certain, Dr Henri Joseph has devised a hook-neurotome, on the principle of the tonsil guillotine, by the aid of which it is possible to divide the nerve with certainty, within a very few millimetres of the apex of the orbit.

Another almost similar, but somewhat more rapid, method is known as the Viennese operation; the same instruments are needed.

First Stage.—The surgeon picks up with the fixation forceps a fold of conjunctiva about 3 mm. or 4 mm. away from the sclero-corneal junction, and divides it with the scissors. Into the space of Tenon, which is opened by the first incision, he passes a squint hook which underlies one of the ocular muscles. With the scissors he now divides this muscle and all the superjacent tissues. The manœuvre is repeated for each of the four recti until the last is divided and the globe can be dislocated forward, as in the previous method.

Second Stage.—The globe is removed as in simple excision.

This operation is distinctly inferior to the preceding; it involves the sacrifice of a large part of the conjunctiva, and the resulting socket is, therefore, smaller and more liable to contraction than that which follows the usual method. The time required is a matter of little importance: if it be thought dangerous to give a general anæsthetic, such as chloroform or ether, it is usually possible to attain sufficient anæsthesia

through cocaine to allow the division of the muscles, and then the administration of gas will give the surgeon time to complete the division of the nerve and the removal of the globe. In neither of these operations, as first performed, did any suture of conjunctiva find a place. It has, however, been recommended with two objects: to promote speedy healing, and to increase the motility of the stump.

If sutures are put in, they are usually carried vertically through the conjunctiva and subjacent capsule, in such a way as to convert the wound into a horizontal line and shut off the orbit from the sac. Recently a rather more elaborate mode has been proposed, by which the muscles are held forward and the movement of the stump improved. Of this method of suturing there are several varieties; the one suggested by Snell (1) has for its object the union of all four recti in the anterior part of the stump.

Snell's Method

First Stage.—The conjunctiva is divided all round the cornea in the usual way.

Second Stage.—One rectus muscle is picked up on the squint hook; through it from side to side is passed a suture, which, therefore, has a firm hold on the tendon. The ends of the suture are tied, "not too tightly," and the needle passed on through the conjunctiva over the muscle. The other end of the suture is cut short, and the tendon divided close to the sclerotic. All the tendons are treated thus.

Third Stage.—The globe is removed in the usual way.

Fourth Stage.—The sutures which hold the lateral recti are tied first, and then those which perforated the vertical muscles.

The advantages which Snell claims for this method are as follows:—1. Prompt arrest of bleeding and more rapid healing; 2. A better and more movable stump; 3. Less falling in of the upper lid.

Another method, suggested by Ernest Clarke (2), deals only with the lateral recti and allows the vertical to retract.

Clarke's Method

Instruments.—In addition to the instruments usually required for excision, the surgeon will need two pairs of Prince's forceps, a needle-holder, needles armed with catgut and silk.

First Stage.—The conjunctiva is divided in the usual way.

Second Stage.—The surgeon passes a hook under the external rectus, isolating it from the surrounding parts, and clamps its tendon as close to the globe as possible with a pair of Prince's forceps. Then he divides the tendon between the clamp and the eye.

The internal rectus is clamped and divided in the same way. The vertical recti are divided merely and not retained in any way.

Third Stage.—The eyeball is removed.

Fourth Stage.—A catgut suture is passed through the external rectus close to the clamp, and the clamp is taken off; the suture is then passed through the conjunctiva and capsule of the lower lip of the wound rather to the inner side of the middle line, and the muscle fixed here. In a similar way the internal rectus is fixed to the upper margin of the wound. Lastly, the upper and lower lips of the wound are brought together by two or three strong silk sutures.

Todd's Method

Certain surgeons are in the habit of closing the cavity left after the removal of the globe by a purse suture. Todd (3), in the *Ophthalmic Record* for May 1902, gave the following simple method:—

First Stage.—The conjunctiva is divided all round the cornea in the usual way.

Second Stage.—The surgeon picks up the tendon of the rectus superior on the squint hook, and passes a curved needle through the conjunctiva over it and through the tendon, thence onwards through the tendon and conjunctiva to the surface. The tendon

is now detached from the globe by scissors. In a similar way the same suture is passed through the three other recti muscles, which are in turn divided.

After the globe has been removed, the conjunctiva and tendons are drawn together by tying the ends of the single suture.

These modifications are certainly of value in improving the appearance of a patient after excision, but none is so good as that of Adams Frost, which will be described later. When, from any cause, this last operation is inadvisable, one of the methods just demonstrated should be chosen.

It is something of a surprise at first sight that this operation, which opens freely a serous space continuous with the meningeal cavity, is rarely associated with meningitis, and, further, that this complication, if it occur, seems to be due to infection through the orbital roof and not to extension along the nerve-sheaths. The two factors that ensure this are: first, free drainage, and, in the second place, the direction of the lymph-current, which is from the skull forwards along the optic sheaths.

There is, however, little doubt that if the eye is in an active state of suppuration there is a slight risk attached to enucleation, and it was for this reason that some of the other operations were suggested.

So far as we have gone there is nothing against enucleation, but, on the other hand, as we have already seen, many advantages may be claimed for it. It is easy of performance, almost without risk, requires few instruments, and little time for recovery. Patients can, as a rule, leave the hospital less than a week after their admission. The disadvantages are almost entirely connected with the after-conditions.

The most important failure is the grave deformity which follows. The fat and muscles remaining after removal of the eye form a concave stump, against which the artificial eye is placed. The upper lid always falls back into the orbit, and leaves a deep hollow. The movements of the stump are

themselves imperfect, and the transmitted movements of the artificial eye are still less.

The vacant, staring look is very noticeable, so that many people prefer the frank deformity of an empty socket. And this, though the chief, is not the only, fault to be found with the operation. The prothesis is concave, and between it and the concave stump a large space is left, in which secretion accumulates, and, decomposing, irritates the conjunctiva, giving rise to chronic conjunctivitis.

The discharge then, in turn, roughens the surface of the eye, and rapidly destroys its polish, until it is unfit for wear.

Lastly, the perpetual irritation gives rise to chronic inflammatory changes in the sub-conjunctival tissue and the underlying capsule of Tenon, so that bands are formed which, cicatrising, make the culs-de-sac shallow and render the retention of an artificial eye difficult, and sometimes impossible.

When a simple enucleation has been performed, the practitioner may be asked to remedy the resulting deformity; three methods then are open to him. He may attempt to improve the existing stump by dissecting up a pocket of tissue and inserting a glass sphere. This is not likely to be successful in greatly improving the movement, though it may improve appearances.

Suker's Method

Suker (4) advocates the use of paraffin injections for a similar object.

The parts must be well cocainised and the bleeding prevented by free use of adrenalin.

Instruments. — Fixation forceps, speculum, narrow scalpel, syringe for injecting paraffin, needle and needle-holder.

First Stage.—The surgeon seizes with the forceps the apex of the socket and draws it forward. Then he plunges the point of the knife into the tissues at this point for a distance of about 3 mm., and at this depth makes a fairly large pocket by sweeping the knife round in a circle, keeping the anterior

wall of the pocket about 3 mm. thick, and not enlarging the external puncture.

Second Stage.—He then passes a suture across the opening and injects the paraffin, filling the cavity but not distending it. Lastly the suture is tied.

Considerable reaction follows the operation, and if the quantity of paraffin has been too large, the anterior wall of the pocket may give way and the mass will be extruded.

An almost similar effect is gained by using the thick artificial eye known as Snellen's. This fits the stump better, and makes the upper lid more prominent.

Lastly, by wearing a convex glass in front of the glass eye the sinking in is partly hidden.

None of these devices is entirely satisfactory, and none of them affects the shallowing of the fornices. As has already been stated, it will sometimes be found that sockets, many years after enucleation, become so shallow by the growth of bands that no glass eye can be worn. This is a great disadvantage to people who are at all dependent on their appearance for employment; it is then necessary to try to remedy the defect by operative procedure. If the socket is merely obstructed by a single band, it is often possible to divide it, and by the immediate use of the glass eye, to prevent, for a time at least, its reappearance. Sometimes, however, the whole cul-de-sac is shallowed, and this is a more serious matter. The lower cul-de-sac is that usually at fault. Many operations have been suggested for the relief of this condition.

It is sometimes possible to correct the defect by a simple proceeding, and it may always be tried first, since it is not likely to do harm. This is to pass the needles of a doubly armed suture, from the lower cul-de-sac, down to emerge on the cheek, or even in the groove between the cheek and the gum. There remains a loop of silk, pulling down the fornix, and the good effect may be permanent. The only harm that can follow is suppuration along the track of the needles. If this fails, some

plastic operation must be performed. Maxwell (5) has recently described a method which is at once simple and apparently effective.

Maxwell's Operation

Instruments.—Scalpel, dissecting forceps, pressure forceps, glass mask, needles and needle-holder.

First Stage.—An incision is made at the bottom of the shallow cul-de-sac in its whole length, some 5 or 6 mm. deep. It is made the same depth along all its extent (*a b* in the diagram).

Second Stage.—On the skin of the lid are made two incisions, one about one-sixth of an inch below the lid-margin and the other curved below this, enclosing between them a semilunar area of skin about 12 mm. broad in the widest part. The length of this curved incision (*c d* in the diagram) must be greater than that of the first. The crescent of skin thus marked out is going to form the lining of the new cul-de-sac.

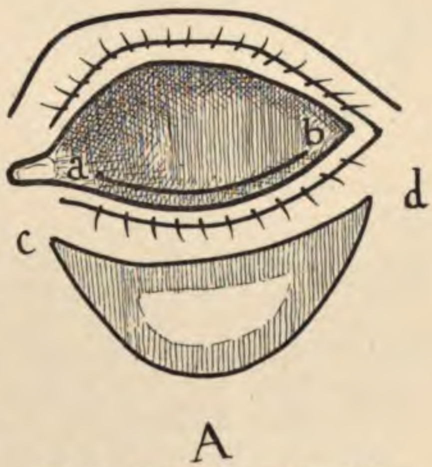

FIG. 87.—Maxwell's operation. *End of fourth stage.*

Third Stage.—The upper limiting incision of the crescent is deepened until it joins the incision in the cul-de-sac. The margin of the lower lid now forms a bridge attached only by its two extremities.

Fourth Stage. — The crescent of skin is dissected up from its borders until only a relatively small part (about one-sixth of the whole) near the centre remains attached to the subjacent tissues. This is represented as unshaded in the diagram.

Fifth Stage.—The bridge of skin bearing the lashes is held forwards, and the crescent slipped under. The two extremities are secured into the angles of the first incision, and to its posterior lip the upper border of the crescent is fastened by two or three sutures.

Then the lower border of the crescent is brought up and stitched to the conjunctival edge of the bridge. The crescent is thus doubled on itself, and forms a groove, the posterior wall

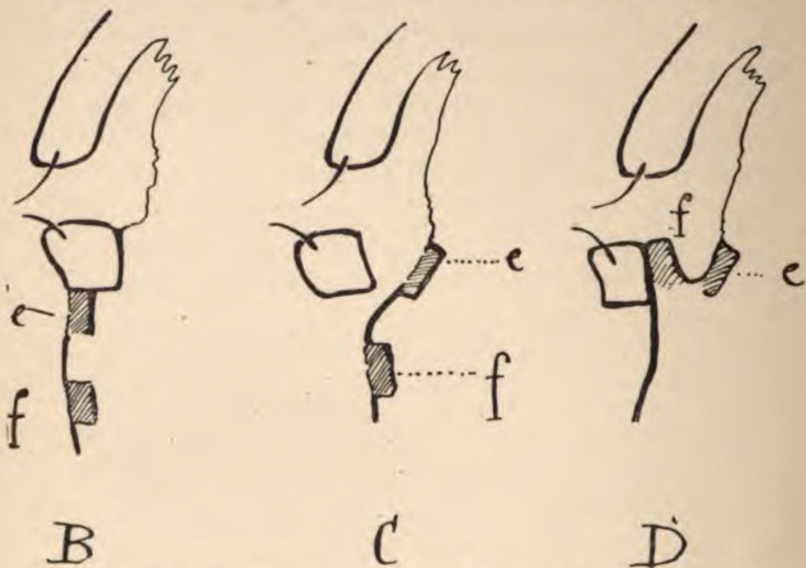

FIG. 88.—Maxwell's operation. Diagrams to show formation of new cul-de-sac. In each the parts *e f* represent the upper and lower parts of the crescent flap.

of which is formed by the upper, the anterior by the lower half of crescent.

The undissected pedicle holds the floor of the groove down.

Sixth Stage.—It remains to close the wound on the surface of the lid, and this must be done carefully or there will be a troublesome scar. The two edges are very disproportionate in size; the lower is much longer than the other.

The first step towards closing the wound must be a stitch in the centre of both edges, then one on each side midway between

the centre and the extremities. The coaptation of these two edges is the most difficult part of the operation.

This completes the whole procedure, but, before the pad and bandage are applied, a glass mask, preferably with a central opening, must be placed within the lids to depress the new-formed cul-de-sac until healing is advanced. It should be left in for a week or ten days; the central opening is an advantage, as it enables the socket to be washed out easily.

Cross's Operation

Cross (6) of Bristol has described an operation for the relief of a contracted socket, which is not difficult of performance.

Instruments.—Scalpel, dissecting forceps, pressure forceps, scissors, needles and needle-holder.

First Stage.—The surgeon makes an incision half an inch long outwards from the outer canthus dividing this.

Second Stage.—He then marks out and dissects up a flap of skin, extending down and outwards from the upper lid with a pedicle attached to this. (If the skin of the upper lid be redundant, a flap may be cut from this having the base attached to the outer side of the external canthus.)

Third Stage.—He then makes a horizontal incision across the conjunctiva of the contracted socket from side to side, extending deep into the submucous tissue. From this incision he dissects up the conjunctiva on either side as freely as possible, so as to form a flap adherent to each lid, and leaving a large raw surface in the floor of the socket.

Fourth Stage.—The flap of skin is then twisted on its pedicle and pushed into the orbit between the lids. Here the margins of the conjunctiva are stitched to its edges.

The stiff skin keeps the socket fairly deep.

The twisting of the skin flap and its compression between the lids is an unfortunate point of this operation, since the nutrition of the whole may be interfered with; a slight modification would avoid this. If, after division of the external

canthus, a vertical incision through both lids be made, and a flap cut as in Fricke's operation for ectropion, this flap could be readily passed in and secured without excessive twisting. A small secondary operation to divide the base and reform the outer canthus would be required a few days after.

Operations for the Relief of a Hopelessly Damaged Eye

Group 1.—Operations entailing the removal of no ocular tissue.

1. Tattooing.
2. Dianoux' method of cauterisation.
3. Optico-ciliary neurotomy or neurectomy.

Group 2.—Partial amputation (anterior amputation), with retention of most of the ocular contents.

1. Critchett's operation.
2. Lagrange's variation.
3. Chevallereau's operation.

Group 3.—Evisceration. Removal of most of the contents of the eye.

(*a*) Without the insertion of an artificial vitreous.

Anterior operations:
1. Noyes' operation.
2. von Graefe's operation.
3. Gifford's operation.
4. Ahlström's operation.
5. de Lapersonne's operation.

Posterior Operation.—6. Nicati's operation.

(*b*) With the insertion of an artificial vitreous.

1. Of inorganic matter; Mules' operation. Modifications.
2. Of living tissue. Barraquez' operation.

Group 4.—Modifications of enucleation. Insertion into Tenon's capsule of

1. Glass sphere. Frost's operation.
2. Melted paraffin. Ramsay's operation.
3. Rabbit's eye. Lagrange's orbital heteroplasty.

4. Graft of skin and subcutaneous fat. Rollet's operation.

GROUP 5.—Removal of the globe with neighbouring tissues.

GROUP 1.—In this group no tissues of the globe are removed, but the eye itself is made use of and the need for an artificial eye avoided. The group contains operations of a very different nature, which have only in common these two factors.

The representatives chosen for description are:

1. Tattooing, combined, if needful, with tenotomy.
2. Dianoux' method of cauterisation.
3. Optico-ciliary neurotomy and neurectomy.

The substitutes for enucleation are various in their design. In some cases the surgeon is set to solve the problem, how to give the best cosmetic result to an eye which has lost all vision from ulceration, which has the cornea opaque and of approximately normal curvature, while the size of the globe is not diminished. In such patients it has been suggested that the surgeon may tattoo, in various coloured pigments, an imitation of the uninjured fellow, on the leucoma, in this way improving on the original suggestion of de Wecker, who was the first to advise the formation of a "pupil," in pigment, on the damaged eye.

Researches of various surgeons have resulted in the discovery of a number of pigments which can be used for the tattooing, without injury to the eye; they include black (lamp black), red (cinnabar), brown (a mixture of cinnabar, black earth of Sienna and Sepia), yellow (raw Sienna), blue (ultramarine or cobalt), grey (powdered graphite), and white (chinese white). (Holth.)

In preparing the pigments it is necessary to obtain them in a pure state as a very fine powder; this powder is sterilised by dry heat and mixed with a few drops of a sterilised solution of gum arabic immediately before use.

For the operation of tattooing, the surgeon requires a small corneal trephine, of about 5 mm. diameter, to mark the pupil, a larger of about 11 mm., to mark out the corneal margin, a

scalpel, a sharp spoon and a bunch of needles, four fine needles surrounding one with a blunt end, so arranged as to prevent too deep perforation.

The method which Holth (7) recommends is as follows:—If the pupil alone is to be made, the surgeon marks out its limits with the small trephine, and with the sharp spoon removes all the contained epithelium. Then with the needles he punctures the stripped surface all over, and after this dips the points into the black and repeats the puncturing, until washing has no effect on the coloration.

When all the details of the iris and pupil are to be reproduced, he begins by marking out on the leucomatous surface a ring with the large trephine, and tinting this with black. It is again necessary to remove the epithelium and then incise the tissue of the cornea radially with a knife. After this the pigment is pricked in with the bunch of needles.

Darier and de Wecker have suggested that when the eye is shrunken it may be made more prominent and the deformity concealed, by tenotomy of all the four lateral recti. Trousseau (8) recorded, in *La Clinique Ophtalmologique*, vol. xi., a case which was successfully dealt with by this method.

Dianoux (9) has suggested another procedure to replace, especially in children, excision of a bulging or staphylomatous eye.

There are many objections, surgical and sentimental, to the excision of a child's eye that can be saved at all. There is a good amount of evidence—not, perhaps, absolutely conclusive—that the bones of the orbit, and, indeed, the whole face on that side, fail in their proper development if the eye have been removed in early infancy. The thesis may be regarded as conclusively proved in the case of young animals other than human; the removal of the eye of an infant rabbit is always followed by imperfect growth of the sphenoid and malar, but the operation must be performed in the first months of life. When we come to the human eye there is no certainty; measurements on this point are few and unconvincing. But the general testimony shows, at the least, a marked prejudice against removal

before the child has reached puberty. Probably, judging from analogy in the lower animals, it would suffice to put off interference until the fifth year, to guard against all risk of maldevelopment.

When the eye must be removed, enucleation produces marked deformity, which renders the unhappy child the butt of its companions' primitive humour; and this may do great moral damage to a sensitive child.

Dianoux' Method of Treating Anterior Staphyloma in Children

The object of this operation is to reduce the eye to about the normal size, leaving a stump on which the surgeon may afterwards tattoo an iris and pupil.

Instruments.—Speculum, fixation forceps, galvano- or other cautery.

A general anæsthetic, chloroform, is necessary.

First Stage.—The surgeon draws with the cautery, at a dull red, a star on the cornea; the rays vary in number directly with the area of the ectasia, and commence a little within the edge of the cornea.

At least 1 mm. of tissue must separate two adjacent rays.

The cautery is taken over and over the rays until at least two-thirds of the thickness of the cornea are burnt.

Second Stage.—Then he traces in the centre of the bulging area a small circle about 2 or 3 mm. in diameter, and gradually deepens it, finally perforating the centre with the cautery at a bright red, and allowing the aqueous to escape.

For dressing he sprinkles the eye with bismuth and puts on a compressive bandage, which he allows to remain untouched for three days; at the end of this time he changes the bandage morning and evening, but continues its use for several weeks, instilling at each dressing eserine and cocaine.

It is very important, says Dianoux, to avoid attempting to reduce the volume of the eye too much at the first operation; it is advisable to leave the stump too large, since contraction is

continuous for at least three months after. If the ciliary processes have undergone atrophy as a result of the pressure to which they have been exposed, the globe will often shrink very much in after time.

The cases in whom the result is most doubtful are they whose enormous eyes have caused atrophy of the retro-ocular fat. When this has been absorbed, it is never renewed.

Tattooing will, later, much improve the appearance.

Optico-ciliary Neurotomy

It is recorded by Von Graefe (10) that he had several times divided the optic nerve in cases of absolute glaucoma as a means of relieving pain without enucleation. The details of the procedure are not given, and the method was not taken up. Later, in 1876, Boucheron recommended the division of the optic and ciliary nerves as a substitute for enucleation in all instances where the larger operation might be necessary.

Boucheron's (11) Operation

Instruments.—Speculum, fixation forceps, strabismus scissors, squint hook, enucleation scissors, needles and needle-holder.

A general anæsthetic is necessary.

First Stage.—The surgeon makes a horizontal incision over the tendon of the rectus internus, and picks this up on the squint hook.

Second Stage.—He then passes two sutures through the tendon, first from the superficial surface to the deep, close to the cornea, and then from the deep to the superficial surface about 3 mm. nearer the muscle fibres. He then carefully divides the tendon in the interval.

Third Stage.—Now passing the large curved enucleation scissors into Tenon's space, he feels the optic nerve, and placing one blade on each side of it, he divides it at a single cut, together with the ciliary nerves, which enter the globe alongside of the second.

By pressing the points back towards the optic foramen, the optic nerve is cut long. There is pretty free hæmorrhage following on the division of the vessels at the posterior pole of the eye, and it is usually necessary to close the lids at this stage of the operation and apply firm pressure until the hæmorrhage is stopped.

Fourth Stage.—When this takes place the eye is again rotated outwards, the end of the nerve examined, and resected again close to the globe, if the surgeon desires; then the tendon is secured by the sutures which were passed in the second stage, and the conjunctival wound closed also.

Firm pressure is required for some hours after the operation is finished.

It is not absolutely necessary to divide the tendon of the rectus internus; the optic nerve may be cut by passing the scissors into Tenon's space between the inferior and internal recti; it is not quite so easy, but it is still not difficult, to examine the posterior pole of the eye after this division. This, as a matter of fact, was Boucheron's first method.

The operation was originally recommended by Boucheron as a substitute for excision in those cases in which sympathetic ophthalmia was to be dreaded; the inventor relied on the theory of Deutschmann as to the mode of propagation of this disease, according to which it spreads along the optic nerves; it has been shown, by unfortunate clinical experience, that the protection given by this operation is inadequate, and in a certain number of cases sympathetic inflammation of the fellow eye has followed. The original scope for the procedure has therefore been much reduced, and if it be undertaken at all, it will be for such conditions as hæmorrhagic glaucoma, in which the eye is hopelessly lost as a visual organ and yet is exposed to severe attacks of pain.

The relief, in these cases, is usually complete, but the great effusion of blood which not infrequently follows, gives occasion to severe pain for many days in some patients.

Golowine (12) has described a more complicated plan, and in

its course removes a considerable length of the optic nerve. He calls the method optico-ciliary neurectomy; it is in idea and performance very little different from the method of Boucheron.

The following are the chief differences:—

Golowine advocates the external route after division of the external rectus. He avoids hæmorrhage by clamping the optic nerve in pressure forceps and dividing it in front of the clamp.

This is allowed to remain fixed on the nerve for about ten minutes after it has been divided. This would seem to be a not unimportant point, since the exophthalmos from the hæmorrhage is, in the ordinary operation, often troublesome.

Lastly, he draws attention to the importance of searching carefully for the branch of the ciliary nerve which lies on the inner side beneath the internal rectus. This twig not uncommonly escapes when the optic nerve is divided, and unless the surgeon knows of its existence and looks for it, the whole operation may be a failure, since the pain for which the operation was undertaken may persist with little or no diminution so long as a single twig remains undivided.

Group 2.—In the second group some part of the ocular contents is removed, and the globe, lessened in size, serves as a support for an artificial eye. In the older methods the cornea was removed; in some of the more modern it is retained, though incised.

These procedures have been given up almost entirely in England, because they have been proved to be not without a real danger of sympathetic inflammation; they are still employed to some extent abroad.

Amputation of the Anterior Segment of the Globe

The unsightly eyes which so often result from ophthalmia neonatorum have exercised the minds of many surgeons in an attempt to deal with them to the best advantage. When the whole globe is much enlarged, and the cornea protrudes, a hideous, shapeless mass, between the lids which cannot close

over it, operation is needed, not only for the pain which is commonly suffered, but also for the removal of the deformity.

The objects of Critchett's (13) operation were to reduce the damaged eye "to a firm elastic bulb, that shall be fully influenced by the various muscles, and shall be about a third less in size, or, at any rate, in its antero-posterior measurement, than the normal eye, this condition being the most favourable for the employment of an artificial eye."

Several surgeons had attempted, before Critchett, the removal of an unsightly staphyloma, but they had not met with much success; in many cases the wound had not healed, or had eventually healed with a weak, yielding cicatrix. The first useful method was that which we are now about to describe, and from this circumstance all amputations of the anterior half of the eye are very often spoken of as Critchett's operations.

Critchett's Operation

Instruments.—Speculum, four or five needles and needle-holder, knife, scissors and dissecting forceps.

First Stage.—The needles are passed through the mass at about equal distances apart, just outside the lines of proposed incision. They are left *in situ*, with the points and eyes emerging.

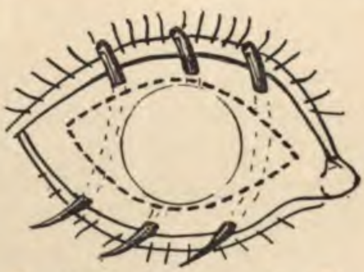

Fig. 89.—Critchett's operation. The parts within the dotted line are removed.

Second Stage.—A small opening is made in the sclerotic in some part of the proposed incision, with the knife, and two incisions made with the scissors enclosing an elliptical piece, just within the extremities of the needles.

Third Stage.—The needles, with their sutures, are drawn through and the sutures are tied, bringing the edges of the sclerotic into apposition.

The advantages of passing the needles in this way are three: they relieve tension slightly, they serve to mark the lines of incision, and, lastly, serve to retain the vitreous which would otherwise escape.

In the hands of its inventor this operation gave very good results, and in favourable cases might yet be used without disadvantage. It has almost been given up in England, chiefly on account of the slight risk of sympathetic ophthalmia, but is still not infrequently performed in France, where it has undergone modifications of various details at the hands of Aubaret, Picot, and Lagrange, among others. These are chiefly planned to increase the resistance of the tissue placed over the gap in the ocular capsule.

One of the latest modifications is that of Lagrange (14).

Lagrange's Operation

Instruments.—Speculum, fixation forceps, scissors, squint hook, Beer's knife, needles and needle-holder

It is convenient to have two needles threaded with rather stout silk of different colours.

First Stage.—The surgeon dissects up the conjunctiva all round the cornea for some distance, laying bare the insertion of the muscles.

Second Stage.—Then picking up each muscle on the squint hook in succession, he secures each with a silk thread. The superior and inferior recti should be secured with silk of a different colour from that used to the lateral tendons.

Third Stage.—After all the four tendons are held, each by a separate silk thread, the surgeon passes a purse-string suture round the mouth of the conjunctival opening.

Fourth Stage.—The next stage in the operation is the removal of the staphylomatous cornea and as much of the ciliary region as the surgeon thinks necessary. If the eye is at all irritable, and shows signs of old-standing cyclitis, it is better to remove all the ciliary zone. With this, of course, is removed the iris, the lens, and part of the vitreous.

Fifth Stage.—The purse-string suture then is tied loosely just with sufficient firmness to prevent further loss of vitreous, and the muscle sutures are tied in pairs, dragging the tendons forward under the conjunctiva over the open gap in the sclero-corneal capsule.

Then finally the purse-string is tied firmly, or if the surgeon mistrusts this form, replaced by interrupted sutures.

A very similar operation has been proposed recently by Chevallereau (15), under the name of "combined transverse keratotomy." The object of this, as of all such procedures, is to give a stump which will be more prominent than that after a simple excision.

Chevallereau's Operation

Instruments.—Speculum, fixation forceps, Graefe's knife, iris forceps, cystitome and curette.

First Stage.—The surgeon makes an incision completely across the cornea in the transverse diameter.

Second Stage.—Passing the iris forceps into this large wound, he grasps the iris firmly and, with a twist, tears it from its attachment all round the circumference.

Third Stage.—He then tears the lens capsule with the cystitome, and removes the lens with the curette.

This completes the operation; the speculum is at once removed and a pressure bandage applied.

It is of importance, says Chevallereau, that the operation be performed rapidly; if the performance be leisurely, a large clot of blood will collect and prevent union of the flaps.

GROUP 3.—The chief feature of this group of operations is the removal of the ocular contents as completely as possible. A secondary division in the group is formed by those cases in which a foreign body is placed in the empty sclerotic, to increase the size of the stump and with it the motility of the prothesis. Since Tenon's capsule and the conjunctiva are little

interfered with, it is quite uncommon to find cicatricial bands appearing in the cul-de-sac at any period after evisceration.

(*a*) Without the insertion of an artificial vitreous.

Anterior operations:
1. Noyes' operation.
2. von Graefe's operation.
3. Gifford's operation.
4. Ahlström's operation.
5. de Lapersonne's operation.

Posterior operation.—6. Nicati's operation.

(*b*) With insertion of an artificial vitreous.

1. Of glass. Mules' operation and modification.
2. Of living tissue. Barraquez' operation.

Group 3 (*a*).—

The first reference to evisceration is to be found in the account of the Fourth International Congress of Ophthalmologists.

Noyes (16) here stated that he was accustomed to deal with cases of suppurating wounds, and more especially panophthalmitis, by incising the cornea freely and wiping out the contents of the eye with a sponge until the sclerotic was left white and glistening. He thought that it would prove an efficient safeguard against sympathetic inflammation. Later, in 1884, von Graefe (17) revived the proceeding to avoid enucleating eyes in a state of panophthalmitis, because in some instances this had been followed by meningitis. His method differed from that of Noyes in that he excised the whole cornea and the surrounding sclerotic. The stump, therefore, was smaller than that left after Noyes' operation, but larger than that after enucleation.

Gifford (18) expresses himself strongly in favour of simple evisceration. What is usually called by that name is, as he points out, really evisceration with excision of the cornea. The removal of the cornea is, in his opinion, a needless mutilation, and he advises all surgeons to leave it whenever possible; the retention of the cornea ensures a larger stump than that which follows the common operation, and gives no greater risk. He describes two methods of performance.

Any "simple evisceration" is often called Gifford's operation, even though the details may not be the same as those recommended by Gifford.

Gifford's Operation

(First Method)

Instruments.—Speculum, straight strabismus scissors, fixation forceps, knife (scalpel or von Graefe's linear knife), sharp spoon, needles and needle-holder.

First Stage—The surgeon makes an incision close to the cornea through the conjunctiva, extending from the middle of the insertion of the external rectus to the middle of the insertion of the superior. From the lower border of this incision he then makes a second running up- and backwards to the retrotarsal fold. The triangular flap of conjunctiva enclosed between these incisions is dissected up, so as to lay bare the sclerotic.

Second Stage.—He then makes, with the knife, an incision through the sclerotic, meridionally along one radius of the globe, between the two muscles whose tendons can be seen. This incision must be about 18 mm. long.

Third Stage.—Through this opening he removes the contents of the eye, making use of the sharp spoon, if it be required, to clear the ciliary body cleanly away.

Fourth Stage.—The conjunctival flap is then replaced and secured by a few points of suture.

(Second Method)

First Stage.—The surgeon makes an incision straight across the cornea from side to side and continues it into the sclera as far as he thinks necessary.

Second Stage.—Through this he empties the eye. No sutures are put in the cornea.

Gifford says that he was disappointed that the resulting stump was not always large enough to carry an artificial eye

successfully. He therefore, in some cases, inserted one of Mules' globes into the empty sclera and secured it by suturing the cornea. This converts the operation into a modification of Mules', similar to that which one of us has described, and which will be found under that head.

Ahlström, of Gothenburg, preserves the cornea in exenteration, in order to have the resulting stump as large and to keep the conjunctival sac as capacious as possible.

Ahlström's Operation

Instruments.—Beer's or von Graefe's knife, forceps, sharp spoon.

First Stage.—The surgeon makes with the knife a puncture, about 1 mm. above the horizontal meridian and a little external to the sclero-corneal junction. He passes it across the anterior chamber to make a counter-puncture at the corresponding point on the opposite side; then he cuts downwards parallel with the plane of the corneal insertion and makes a flap equal to about three-fifths of the cornea.

Second Stage.—He then raises the flap out of the way by the forceps and scrapes out all the contents of the globe with the sharp spoon. Special care is needed to evacuate the choroid and ciliary body completely.

No sutures are put in; the interior of the eye is washed out by irrigation, and the corneal flap replaced in position. A pressure bandage is applied. This completes the procedure.

Ahlström claims for this method that the convalescence is shorter and the reaction less than that found when keratectomy is performed.

A variety of evisceration, "exenteration ignée," is strongly recommended by de Lapersonne (19) in cases of panophthalmitis, which, as we have already pointed out, are notoriously unfavourable for enucleation.

He incises the cornea freely in a cruciform manner, and then burns up the contents of the globe with Paquelin's cautery,

holding the flaps of the cornea apart, and introducing the glowing point repeatedly into the vitreous and thus disinfecting by heat the tissues that are left.

SUBENUCLEATION

Nicati's Operation

Nicati (20), by his operation of subenucleation, attempts to preserve the anterior half of the sclero-corneal capsule while removing the posterior half and all the ocular contents.

Instruments.—Speculum, fixation forceps, scissors, sharp hook, needles and needle-holder.

First Stage.—The surgeon makes with the scissors a button-hole through the conjunctiva over the insertion of the internal rectus.

Second Stage.—The tendon is held forward in forceps, and two sutures armed at each end with a needle are passed through it from its deep surface, one near the upper, one near the lower border, and onward through the overlying conjunctiva. The tendon is then divided between the sutures and the globe.

Third Stage.—From the incision the capsule is opened above and below the tendon, so as to allow the entrance of scissors, with which the optic nerve is divided as in enucleation.

Fourth Stage.—The surgeon now takes the sharp hook, and with it brings into sight the posterior pole of the globe which is stripped of the attachments of the obliques.

Fifth Stage.—He then divides the scleral coat all round behind the insertions of the recti, and removes the remainder of the capsule and the whole content of the globe, paying special attention to the ciliary body and iris which are in connection with the anterior half.

Sixth Stage.—Lastly he takes the needles on the deep ends of the sutures, which were passed during the second stage, through the tendon of the internal rectus, and passes them through the corresponding ends of the tendon and conjunctiva which were left adherent to the globe. The ends are then tied, closing the wound in the conjunctiva and uniting the tendon.

Nicati states that the healing is more rapid than after simple enucleation, and that an excellent stump is left; the latter is probable, but the former is difficult to understand.

GROUP 3 (*b*).—

Mules' Operation

Mules (21), in 1884, dissatisfied with the cosmetic results of previous operations, proposed to place a hollow glass sphere in the empty sclerotic, and thus make a large prominent stump for the artificial eye. His method, which, with slight modifications only, remains the best cosmetic operation, will now be described.

Instruments.—Speculum, fixation forceps, cataract knife or scalpel, scissors, sharp spoon, artificial vitreous and introducer, needles and needle-holder.

First Stage.—The surgeon with the knife cuts half round the cornea, and completes its removal with scissors.

Second Stage.—Through the gap thus left he removes the contents of the globe, being specially careful to remove the uveal tract as completely as possible. For this the sharp spoon is useful.

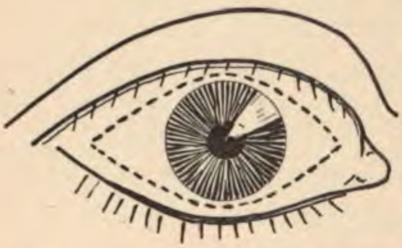

FIG. 90.—Mules' operation. The parts within the dotted line are removed.

Third Stage.—The circular wound left by removing the cornea is not readily closed by sutures. So it is converted into an elongated ellipse, with the long diameter transverse, by the removal with scissors of two somewhat triangular portions, one on each side. All hæmorrhage should be stopped; it is most easily done by washing out with some hot antiseptic.

Fourth Stage.—A glass globe of suitable size is slipped by means of the introducer into the sclerotic, and the wound closed over it by sutures. (Mules advises that the sclera and conjunctiva should be united separately, but this seems unnecessary, and the sutures may include all the tissues.) Three or four are

usually sufficient. The surgeon must estimate what size of globe will be retained, and at the same time give a useful stump. Practically globes between 11 and 13 mm. are most useful.

The patient should be kept quiet during the first week or ten days of the convalescence, and the stitches should not be removed until at least ten days have elapsed, when the wound will be found soundly healed. A glass eye can be worn in a month.

In a certain number of cases the central stitch gives way and the globe emerges. Naturally the smaller the globe the less the number of failures and the less the reaction; but, on the other hand, the smaller the stump the less perfect the cosmetic result.

Although with the escape of the globe Mules' operation may be said to have failed, it may be possible to refresh the edges and insert a smaller sphere. This has, in the writers' experience, rarely been successful. Even at the worst, however, the remaining stump is that of an evisceration, much more solid and more prominent to bear the artificial eye than that after complete excision.

It is clear that the reason of the special weakness of the central stitch is to be sought in the greater tension put on it, because of the imperfect adaptation between the shape of the inserted vitreous and that of the sclerotic after removal of the cornea.

FIG. 91.—Modification of Mules' operation. The line shows the incision.

It has been proposed by one of us to make this adaptation closer, by preserving the cornea, and making a long curved incision through the sclera above it. In this way, after the introduction of the globe the tension on the central stitch is less than that on the lateral, and, since the wound is entirely in vascular tissues, the healing is usually rapid.

It cannot be judged yet how far this modification is successful in ensuring union. So far the results have been very favour-

able. The only case of failure among nine successes was one where the operation was undertaken on account of a large contused and lacerated wound of the globe, which, having been with difficulty closed at the time of operation, eventually gave way, allowing the escape of the sphere.

Others have dealt with the difficulty in a different way, by making a long transverse incision across the cornea extending into the sclera. The disadvantage here is that the wound is in non-vascular tissue, and therefore heals with less rapidity.

Other substances—metal spheres, masses of sponge, etc.—have been proposed to replace the glass sphere of Mules, but so far without benefit.

Barraquez (22), at the Madrid Congress of 1903, proposed that the glass sphere of Mules might be replaced with advantage, by a mass of fat, cut according to his suggestion, from the gluteal region of the patient. This graft, being an organic living substance, would, he thought, heal into the empty sclerotic more kindly than a glass globe. The suggestion has been put into use by Troncoso as well as the originator, and the results are said to be very good.

Pflüger (23), of Berne, at the International Medical Congress at Paris in 1900, stated that theoretical reasoning had led him to use perforated globes in preference to complete spheres of glass; their value, in his mind, was that the granulation tissue took better hold on them. It has been our experience that a considerable number of the globes which were extruded from the eye were imperfect and showed a small hole, the interior being filled to some extent by fluid. This small hole has therefore seemed to us an unfavourable condition.

Lang uses gold spheres. Silver spheres have been used, but are objectionable as they give rise to argyrosis of conjunctiva and lids.

Group 4.—The fourth group of the operations contains those procedures which are essentially modifications of simple excision, and have for their object an immediate improvement of the resulting stump. The modifications by sutures have been already

dealt with. In the methods now to be described, some tissue, organic or inorganic, is placed in the empty capsule of Tenon, and makes the stump convex instead of concave.

The selected operations are—

1. Insertion of a glass sphere (Frost's method). Injection of paraffin (Ramsay).
2. Orbital heteroplasty.
3. Implantation of a graft of skin and subjacent fat (Rollet's operation).

Adams Frost's (24) Operation

Frost, in 1885, suggested that a glass globe should be put into Tenon's capsule after enucleation. The operation was done as follows:—

Instruments.—As for enucleation, with the addition of Mules' artificial vitreous and introducer.

Enucleation is performed in the usual way.

Then, without waiting to stop hæmorrhage, the surgeon introduces a glass sphere about 13 mm. in diameter into Tenon's capsule and sews up the wound with three or four stitches. It is well, while the stitches are being passed, to grasp a large piece of both lips of the wound in forceps, and put the needles through the tissues at a distance of at least 4 mm. from the edge. Unless this be done the globe will probably escape during the healing. The stitches pass through conjunctiva and Tenon's capsule, and the central one probably also through the tendons of the vertical recti. The pressure of the globe soon stops all hæmorrhage.

The reaction is less than that after Mules' operation, but more than that which follows enucleation. The length of convalescence and the cosmetic results are also intermediate.

Ramsay's Operation

Ramsay (25) has drawn attention to the good results which may be obtained by the injection of paraffin into the empty capsule of Tenon, after enucleation. Hertel (26) had published,

a little time before, an article detailing the results of numerous experiments which he had carried out on rabbits, to see whether the orbit would bear the injection of paraffin, and thus give a better stump for an artificial eye than was obtainable by simple enucleation. His results on rabbits were entirely favourable; in some cases he injected hard paraffin, in others inserted a more or less globular mass after removing the eye.

Ramsay seems to have been the first to make use of the injections on the human subject. His method is as follows :—

First Stage.—The surgeon divides the conjunctiva as near the cornea as possible; then passing a squint hook under each rectus muscle in succession, he passes a strand of catgut, with a knot at one end, through the tendon and overlying conjunctiva. The knots prevent the catgut sutures running completely through the tendons.

Second Stage.—The tendons are then divided as close to the sclerotic as possible, and the eye excised as usual.

Third Stage.—The bleeding is now stopped by douching with hot sterilised water, and the capsule, stretched by the four strings, is stuffed with gauze moistened in a solution of adrenalin chloride. A strong purse-string suture is then passed all round the opening of the capsule.

Fourth Stage.—The gauze packing is now withdrawn, the nozzle of the special syringe inserted into the capsule, and the purse suture drawn tight round it. As much paraffin is injected as will distend the capsule, the syringe is withdrawn, and the suture pulled tight so as to prevent the escape of the injected paraffin, and tied. The four catgut sutures are then tied, the upper to the lower and one lateral to the other.

If a moderate amount only of paraffin have been injected, the reaction during the first days of healing is very slight. An artificial eye may be worn over the mass in about a month.

It is difficult to see that the procedure just described has any advantage over Frost's operation. It is said that the glass sphere is liable to fracture, but this risk is purely theoretical, and the injection of paraffin is certainly not devoid

of its own special dangers. In other situations it has been followed by thrombosis of the neighbouring veins. During the formation of a new nose it has several times been the cause of blocking of the orbital veins on one side and total blindness of one eye. Certainly it is not likely that the injection of paraffin into the tissues of one orbit should give occasion to blindness of the other eye, but it is at least possible, and the risk more than counterbalances any objection to Frost's method.

Orbital Heteroplasty

Certain surgeons have tried to combine the safety of enucleation with the maximum of cosmetic effect by endeavouring to implant an excised eye from a rabbit into the capsule of Tenon, hoping that the graft would live and serve as an artificial prothesis. In the first cases, Chibret (27), in *La Revue Générale d'Ophtalmologie* for 1885, describes how he has attempted to implant a rabbit's eye into the capsule of Tenon, from which an eye had been just removed. The ingrafted eye lived for some time; it is even stated that the corneal sensibility returned, so that the patient was as sensitive to touch of the implanted as of the normal cornea, but in about fourteen days the rabbit's cornea gradually dissolved in pus and the resulting stump was not very satisfactory.

Chibret, in the paper mentioned, discusses the point whether such an eye after transplantation could give rise to sympathetic ophthalmia.

Some later experimenters have retained the use of the rabbit's eye, while they have given up the attempt to use it as a substitute for an artificial; it serves, in fact, merely to increase the bulk of the stump. By retaining the living graft, they indeed avoid the presence of an implanted foreign body in the orbit; but, on the other hand, there can be no justification for the use of such a specialised organ, for filling a cavity which might as well, or better, be filled with fat. Such methods as that of Lagrange, in which a freshly enucleated rabbit's eye

is placed within the capsule and the conjunctiva sewn over it, cannot be defended in any respect.

The tissues of the eye are not readily implanted on to other tissues; they lose bulk and form a diminishing stump. On the other hand, skin and subcutaneous fat, or a mass of subcutaneous fat alone, forms an excellent graft.

Rollet's (28) Operation

Rollet implants into the empty capsule, after enucleation, a mass of skin and subcutaneous fat, which he takes for preference from the deltoid region. He uses for the detachment of the muscles from the globe, a rugine.

He describes the operation as follows:—

First Stage.—The surgeon divides with scissors the conjunctiva all round the cornea.

Second Stage.—Each rectus tendon is picked up with the squint hook, and separated from the sclerotic by means of the rugine. It is then held forward by a suture. The insertions of the obliques are also separated in the same way; after this, the sclerotic is completely stripped of all attachments.

Third Stage.—The optic nerve is cut and the eye removed.

Fourth Stage.—Now the surgeon dissects out, from the deltoid region, a round of skin with the whole thickness of the subjacent fat. The circumference of the graft should be a little larger than that of the cornea.

Fifth Stage.—The graft is placed into the empty capsule of Tenon, and the recti tendons are sutured to it by means of the sutures which were placed on them in the second stage. Then the conjunctiva is stitched to the skin all round the margin of the graft.

Rollet claims for this operation that the resulting stump is freely mobile.

Group 5.—

Removal of Eyeball, Conjunctival Sac, and Tarsus.

When the conjunctiva is much shrunken, or when a malignant tumour as eroded the lid margin and is attacking the globe, it

is seldom of avail to attempt a plastic operation which will enable the patient to wear an artificial eye. It is usually better to sacrifice the conjunctival sac and stitch the lids over the raw contents of the orbit, or, if the cavity have been entirely emptied, over the void. This will reduce the subsequent deformity to a minimum.

Green (29) was the first to publish any operation of this kind. Czermak has, later, recommended a very similar procedure. Alt (30) has recalled attention to Green's original paper.

Green's Operation

Instruments.—Speculum, fixation forceps, scissors, squint hook, pressure forceps, needles and needle-holder.

First Stage.—Enucleation is performed in the usual way.

Second Stage.—The surgeon then grasps the conjunctiva in his forceps and draws it out; by a slight dissection he dissects off the tarsal plates with the conjunctiva and removes them.

Third Stage.—Then he removes the borders from both lids.

Fourth Stage.—The raw edges of the lids are then united by several points of suture.

Czermak (31) operates by a slightly different method.

Czermak's Operation

Instruments.—Scalpel, dissecting forceps, speculum, squint hook, fixation forceps, scissors, pressure forceps, needles and needle-holder.

First Stage.—The surgeon splits both lids in the grey line and dissects upwards until he has reached beyond the tarsal plates.

He then draws the tarsal plates down and dissects out the retrotarsal folds. All this tissue is then removed.

Second Stage.—The speculum is then inserted and the eye removed with the remainder of the conjunctiva.

Third Stage.—The lid margins are then stitched together.

It will be noticed that Czermak does not remove the lid margins so long as they are healthy; Green, on the other hand,

lays considerable stress on the advantages of their removal in all cases to ensure an almost invisible scar. It would seem to the writers that the line of lashes, if they can be preserved, would give a more natural appearance than the smooth, unbroken surface left after Green's operation.

The lacrymal glands are left *in situ* in both procedures, but seem to give no inconvenience.

As has been seen from the description just given, there is no great difficulty connected with the performance; it may be undertaken with no great additional risk whenever enucleation has to be performed on account of malignant disease which has invaded the globe and the lids.

To such cases most surgeons would limit its employment, but Alt advises us to use it whenever the conjunctival sac is shrunken so as to make the wearing of an artificial eye difficult or uncomfortable, and even goes so far as to suggest that the operation should be done as a substitute for simple enucleation on working men, to whom the artificial eye is a considerable expense.

Exenteration of the Orbit

In cases of extensive disorganisation of the orbital contents by malignant disease, it is often necessary to remove all the parts from the cavity. If there be a new growth adherent to the bony walls, even the periosteum must be swept away and the bones treated as seems best. The walls are very thin, in some parts dangerously near the cerebrum, and any inflammation of them is not impossibly complicated by meningitis. The surgeon, therefore, will deal gently with the bones of the roof, knowing how narrow are the limits of safety.

The methods will vary a little with the leaving or removal of the periosteum.

First Method

Instruments.—Speculum, scalpel, fixation forceps, curved scissors, dissecting forceps, pressure forceps.

First Stage.—The surgeon makes an incision outwards from

the outer canthus, reaching to the edge of the bony orbit; then drawing the globe strongly forward, he divides the conjunctiva in the upper and lower fornices by two curved incisions, which, passing above and below the eye, unite at the inner and outer canthi.

Second Stage.—Then drawing the eye inwards, he separates the contents from the inner wall of the orbit by repeated small cuts of the scissors. Having freed this part, he attacks the lower, inner, and finally the upper wall, taking special care here to avoid any perforation of the bones. By this cautious dissection the orbital contents are freed back to the apex.

Third Stage.—The whole mass thus separated is drawn forcibly forwards, and the surgeon divides the restraining tissue at the optic foramen, or as near as possible to this, with the curved scissors. There is necessarily very free bleeding, and it is not possible to place a ligature on the vessels in the depth of the orbit where they are cut; the cavity, however, is easily filled with plugs, and these control the hæmorrhage.

Sometimes the actual cautery is of great assistance in this stage of the operation.

It is often useful, since the socket which is left can never carry an artificial eye with comfort, to remove the conjunctiva from the lids and culs-de-sac. There is left a raw surface, as in Green's or Czermak's operation, which heals kindly down on the granulation tissues of the orbit.

If the operator decide to remove the periosteum with the contents of the orbit, the method is a little different. This is the second plan.

Second Method

First Stage.—The incision from the outer canthus, and the division of the fornices conjunctivæ, is made in the way just described. The dissection is extended up to the bone.

Second Stage. — The periosteum is divided all round the

orbital margin and the orbital part of the membrane separated from the bones by means of a rugine. The attachment is usually not very close, and this part of the operation is not difficult.

Third Stage.—When the parts are separated as far as possible, they are cut off as in the former method.

This method has the disadvantage that it robs the bones of their lining membrane, on which they depend for nutrition;

Figs. 92 and 93.—Golowine's operation.

the thin walls can, for the most part, gain enough from the periosteum on the undisturbed surface, but necrosis is not unknown.

Golowine (32) has attempted to make a more cosmetic operation by covering the raw tissues left in the orbit by means of a fold of skin which he takes from the temple. The method is not unlike that of Cross (described above) for restoring a shrunken socket.

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CHAPTER VI

OPERATIONS ON THE LACRYMAL APPARATUS AND BONES OF THE ORBIT

THE secretion and removal of the tears is carried out by a complicated system. The chief part of the fluid is secreted by the lacrymal gland, which is placed in the outer part of the orbit, and consists of two parts—an orbital, larger, and a palpebral, smaller, portion.

The orbital part lies in a concave depression of the frontal bone, to which it is attached by a connective tissue capsule. The anterior border protrudes a little from the orbit; the anterior edge is sharp, the posterior rounded; the ducts are not numerous, rarely as many as six (Alt), and open into the superior fornix of the conjunctiva.

The palpebral portion is smaller, and separated from the orbital by the tendon of the levator palpebræ and the muscle of Müller; on the temporal side, some scattered lobules reach down to the lower lid beyond the outer canthus. The ducts of this gland are separate from those of the upper. Besides these two chief glands, there are many other scattered smaller glands, which are indistinguishable in structure from the larger, and have probably the same function, viz., the secretion of tears. These keep the eye moist when the larger glands have been removed.

The tears run over the eye and tend towards the largest space of the conjunctival sac, *i.e.* the space between the lids

and the caruncle, which is called the lacus lacrymalis; from this pool they are drained by two small canals, the canaliculi.

The openings of the canaliculi are situated at the apices of two small papillæ which arise from the posterior part of the lid margin, the upper about 6 mm., the lower rather further out, about 6·5 mm. away from the canthus. Each opening is very small, not more than 0·2 mm., and often only half this. From the mouth the canal runs vertically, the lower downwards and the upper upwards, for about 2 mm., enlarging in its course, and then bends at a right angle inwards; at the bend there is usually a considerable pouch, extending outwards.

The horizontal arms of the canals run inwards, as has been already said, and converge, to meet after a length of about 7 mm. They often unite before reaching the nasal sac, but sometimes join it separately.

The canaliculi either open together into a small pouch, the sinus of Maier, and thence into the lacrymal sac, or not infrequently enter the sac separately on its anterior and outer wall.

The lacrymal sac is about 15 mm. high, and is implanted in the groove formed by the lacrymal bone and the superior nasal process of the upper maxillary. Its posterior, inner wall, therefore, is in contact with the bone; its anterior is crossed a little above the middle by the internal tarsal ligament, the tendo oculi. A slip from this, passing on the outer side of the sac, is inserted into the ridge of the lacrymal. The lumen of the sac is normally a narrow slit, but the potential space is of considerable size, so that the canal can tolerate a probe 4 mm. in diameter. It is sometimes separated from the sinus of Maier by an imperfect valve, called the valve of Rosenmuller. Upwards it ends in a rounded extremity, below it is directly continuous with the nasal duct.

It is lined by cylindrical epithelium, the cells usually being in two layers, resting on a basement membrane: beneath this membrane is a layer of lymphoid tissue. There is no muscular coat, but elastic fibres are abundant.

The nasal duct runs through a bony canal from the lacrymal sac to the inferior meatus of the nose. Its length varies from 12 to 14 mm.; its greatest diameter is about 4 mm. The mucous membrane of the duct is separated from the bony walls by a venous plexus.

The opening of the duct into the nose beneath the inferior turbinated bone is most often a simple slit; occasionally the canal runs beneath the mucous membrane for a variable distance before the opening.

Operations on the Lacrymal Apparatus

These operations may be divided for convenience into several groups and sub-groups.

Group 1.—The operations, which have for their object the restoration of the natural passages:

(*a*) Operations on the puncta.
(*b*) Operations on the canaliculi.
(*c*) Operations on a diseased sac.
(*d*) Operations on a stenosed duct.

Group 2.—Formation of false passage to the nose.

Group 3.—Obliteration of the passages:

(*a*) Temporary; ligation of the canaliculi.
(*b*) Permanent; removal of the lacrymal sac.

Group 4.—Removal of the lacrymal gland.

Group 1 (*a*).—

Dilatation of the Punctum

In all operations on the canaliculus, and in some on the sac, it is advisable to dilate the punctum as a preparatory measure. The best dilator has a smooth, conical point, and is made of pinion wire, which gives a firm hold. To dilate the punctum, the lid must be slightly everted, and the point of the dilator pressed firmly against a small depression which marks the site of the punctum. The dilator must be passed vertically for about 2 mm., and then horizontally inwards and slightly backwards along the canaliculus.

Sometimes the punctum is congenitally absent. There is usually in these cases a small groove marking the position of the canaliculus, and the site for the closed punctum may be indicated by a shallow depression. A small incision must be made at the point where the punctum should be and an attempt made to find the canaliculus with a fine wire probe. When it is found the canaliculus may be dilated by the common dilator.

Streatfield suggested the following procedure when one punctum is absent or occluded. The canaliculus corresponding to the open punctum should be slit up to the sac, and a suitably bent wire passed into the sac and along the other canaliculus, to the position of the absent punctum. The point of the wire can then be cut down on and the canaliculus slit up. It must be remembered, however, that in a certain percentage of cases the canaliculi join and enter the sac by a common opening.

Reposition of a Malplaced Punctum

Sometimes the punctum is misplaced with the lid in ectropion: the tears then cannot enter and run over the lid margin. An operation on the lid to replace it in the normal position will best relieve the malposition, but if it is refused, slitting the canaliculus will afford relief to the epiphora.

Sometimes an enlarged caruncle interferes mechanically with the normal escape of tears, partly by displacing the puncta and partly by pressing on the canaliculi. Removal of the hyperplasic mass is then advisable. The lids are held open by a speculum, the caruncle seized firmly with toothed forceps, drawn forwards, and excised with scissors close to its base.

Group 1 (*b*).—

Slitting of the Canaliculus

Division of the canaliculus is required for two several conditions. It is necessary as a preliminary measure before introducing probes into the lacrymal duct, since the puncta are only moderately dilatable. It is also a method to reduce the epiphora which follows lagophthalmos.

The operation is performed in the same way in each instance, and, therefore, one description only is required. The instruments needed are a canaliculus knife with a probe point (Weber's pattern is perhaps the best) and a conical dilator to enlarge the punctum.

The little procedure is rather painful, and the pain is not much lessened by cocaine. The whole thing can be done comfortably and easily under gas.

The surgeon, before the gas is given, will do well to dilate the punctum slightly; a drop of cocaine makes this easy. Otherwise it is sometimes difficult to make the beak of the knife enter the canaliculus.

The dilator must pass first vertically for 2 millimetres and then pass horizontally inwards and backwards. The patient then being anæsthetised, the surgeon takes the canaliculus knife and passes it into the canal, with the edge turned towards the conjunctival surface of the lid, until the probe point strikes and is stopped by the inner wall of the nasal sac.

It often makes the passage easier to hold the lid rather outwards, and so stretch the inner part of the canals. Then, holding the lid thus tense, the surgeon brings the handle of the knife into the line of the nasal duct, keeping the cutting edge towards the globe and cutting through the inner wall of the canaliculus.

There is thus made an open gutter on the inner surface of the lid, dipping towards the cul-de-sac and serving to carry off the tears.

If the upper wall of the canal is incised, the wound is apparent on the lid margin, and, though it is equally serviceable for the passage of probes, it is not able to carry off tears in the same way.

After this little operation, the incision in the canaliculus sometimes heals too rapidly, and, therefore, removal of the inner wall is advisable to prevent union of the two surfaces of the wound. A better channel results than after a simple division.

When he desires to remove the inner wall after division of

the canaliculus, the surgeon seizes it in forceps and cuts it away with scissors.

GROUP 1 (*c*).—

Disease of the lacrymal sac is usually dependent on stenosis of the nasal duct. As a result of this stenosis, there is retention of discharge in the lacrymal sac, and subsequently inflammatory changes in the lining mucous membrane. The sac becomes distended, at first with clear mucous (mucocele), but later with mucopus from the invasion of pyogenic organisms. Should the infection spread beyond the mucous membrane of the sac into the submucous tissue, a lacrymal abscess will ensue.

The presence of a mucocele can be determined by pressing firmly with the finger on the lacrymal sac in a direction backwards and inwards. At the same time the lids should be everted, so that it may be possible to watch the puncta, and detect regurgitation of mucus or mucopus from the sac. The patient will usually give a history of long-standing epiphora, and there is commonly a swelling in the position of the sac. The lower canaliculus must be dilated, and the sac washed out with some antiseptic solution at least twice a week. All the excess of fluid must be carefully expressed afterwards. If protargol be used, as is the common practice now, it must not be injected with any force; accidents have followed the involuntary injection of the solution into the areolar tissue of the orbit.

In a large proportion of cases obstruction of the nasal duct is present, as shown by the fact that the drug is not felt or tasted by the patient at the back of the pharynx.

In the more recent cases the blockage is due to the catarrhal swelling of the mucous membrane of the duct; in these, injection of astringents is likely to produce a cure. When the obstruction has organised, cure from this method of treatment is improbable. It is important, while the obstruction is due to catarrhal swelling, to avoid any treatment which may lacerate or in any way damage the mucous membrane. Some chronic cases of obstruction are due to great hypertrophy of the mucous membrane; the lumen of the sac may be filled with fungous

outgrowths. If any attempt be made to free the passage in such a case, it will be found necessary to curette the walls of the sac; for this purpose the canaliculus must be slit up, to allow the passage of a small Volkmann's spoon into the sac. By this the hypertrophied tissue must be removed as thoroughly as possible; the sac must then be washed out with perchloride lotion and firm pressure applied by means of a bandage.

If the entrance of organisms into the sac have brought about an abscess, it must be opened, preferably through the lower canaliculus. If this be unattainable, owing to swelling, an incision must be made through the skin of the face in an almost vertical direction over the inflamed sac. The upper limit of the incision must not extend above the level of the inner canthus, on account of the internal palpebral ligament. While the tissues are acutely inflamed, no probing must be thought of, since a false passage would be easily torn in the softened walls.

A condition closely simulating and allied to that of a dilated and distended sac is sometimes met with: there is a tumour in the region of the lacrymal sac, but no obstruction to the passage of tears nor regurgitation on pressure. Rollet (1), from careful dissection, has shown that there is a cellular presaccular space, which is in these cases transformed into an abscess cavity. In such cases the sac lies in the floor of the cavity, and is often perfectly healthy. The treatment of this condition, which he calls prelacrymal tumour, is to lay the abscess open and scrape the walls carefully, without opening the lacrymal sac. Cirincione (2) states that these tumours are due to caries of the lacrymal bone.

Group 1 (*d*).—

Stricture of the nasal duct is usually secondary to disease of the nose. It may be catarrhal, fibrous or bony; the treatment of the catarrhal form has been already indicated. The fibrous or bony forms require more radical procedure. The stricture occurs at one of two places—either at the lower end of the duct, or, less commonly, at the junction with the

lacrymal sac. It is, as we have said, often associated with mucocele or dacryocystitis.

In all cases attempts should be made to restore the passage. There are three modes of proceeding: (1) Slow dilatation; (2) rapid dilatation; (3) dilatation by styles (constant dilatation).

One of the canaliculi must in any case be divided freely into the sac to allow the entrance of probes of sufficient size.

Slow dilatation is the safest and most usual method. A medium-sized (No. 4) Bowman's probe is entered horizontally along the canaliculus into the sac, until it is felt to touch the lacrymal bone; it is then raised to a perpendicular position, while the pressure against the bone is maintained; the lower end of the probe will then slip downwards and engage in the upper end of the duct. Pressure must be exerted in the line of the duct—*i.e.* downwards, backwards, and a little outwards—until the stricture is passed. Probes may be passed twice a week, the sizes being gradually increased, until one of 2·5 or 3·0 mm. will easily go through the duct. (Theobald advises the use of a probe 4 mm. in diameter.) When the duct is once dilated up, no further treatment may be necessary. Should recontraction take place, a style may be inserted and left *in situ* for a week or longer. (We have known one worn for seven years without injury.) This is the method of continuous dilatation.

If rapid dilatation be thought advisable, a general anæsthetic will be required on account of the pain. A medium-sized probe is used with considerable force, if necessary. The very small sizes are almost certain to make a false passage. After one has passed, the larger instruments may be passed in rapid succession and a large style left in. The slow method will be required afterwards to complete the cure.

Group 2.—

Formation of an Artificial Passage to the Nose

Toti (15) advocates the resection of a piece of bone to include part of the nasal process of the superior maxilla and the entire

breadth of the lacrymal fossa. The nasal mucous membrane is thus exposed, and a round opening made in it, corresponding to the opening in the inner wall of the lacrymal sac.

This method is not much used; the openings tend to close, and the passage of tears is again obstructed.

GROUP 3.—

OBLITERATION OF THE NATURAL PASSAGES

These operations include some of the most useful of the methods for dealing with inflamed sacs. We may temporarily obliterate the canaliculi to prevent the reflux of infective material to the eye, when we fear that a wound may be infected, or we may secure permanent obliteration of the tear passage by excising the lacrymal sac.

GROUP 3 (*a*).—

TEMPORARY OBLITERATION; LIGATION OF CANALICULI (16)

This operation is devised to shut off an inflamed lacrymal sac from the conjunctiva.

A fine wire probe is passed along the canaliculus; a silk suture is then carried, by means of a fine curved needle, round encircling the canaliculus, at a distance of some 3 mm. from the punctum: the probe is then withdrawn and the suture tied tightly. Both canaliculi must be treated in the same way.

GROUP 3 (*b*).—

PERMANENT OBLITERATION OF THE PASSAGES

EXTIRPATION OF THE LACRYMAL SAC

The indications for extirpation of the lacrymal sac are—

(1) Chronic dacryocystitis, which does not respond to simple measures. The usual routine is to attend first to any nasal obstruction, then to wash out the sac with a solution of protargol or argyrol, next to slit up the canaliculus and dilate any stricture which may be found in the nasal duct. If no improvement follow after a fair trial of these milder methods, removal of the sac must be considered.

(2) The association of hypopyon ulcer or ulcus serpens with

dacryocystitis. Here extirpation of the sac is probably the best treatment.

(3) The necessity of an operation on the globe. Even if dacryocystitis has been apparently cured by the milder treatment just indicated, no large operation such as cataract extraction should be performed on the eye without first removing the sac.

(4) Lacrymal fistula; this, the result of allowing a lacrymal abscess to burst externally, often requires removal of the sac for its healing.

There is very little doubt that extirpation of the lacrymal sac is performed all too seldom in this country. At any ophthalmic hospital patients may be seen who have attended for months and even years with chronic dacryocystitis, and all its attendant dangers and discomforts, who would be permanently relieved of their trouble if the operation were performed. Hypopyon ulcer and ulcus serpens, which so often occasion loss of the affected eye, would be almost unknown if all dangerous lacrymal sacs were removed.

Destruction of the lacrymal sac dates back at least eighteen hundred years. Celsus, probably with no knowledge of the sac, was accustomed in cases of lacrymal fistula to cauterise the tissues freely down to the bone, after having first removed the unhealthy granulations round the opening. His results were good, as no doubt at the same time he destroyed the diseased sac.

In 1724 Platner brought forward an operation of extirpation of the sac, combined with the making of a false passage into the nose; he had few followers. An unsuccessful attempt to revive the operation was made in 1830 by Rosas. In more recent literature (up to 1868) we find it mentioned by Arlt and de Wecker, and practised by Mooren, who did not recommend it.

At the Second Ophthalmological Congress of Heidelberg, in 1868, Berlin (3) read his classical paper. His first case was a patient aged sixty-five years, suffering from chronic dacryo-

cystitis on one side. Berlin cut down upon the swelling, and, having opened the sac, attempted to remove it by seizing the posterior wall in forceps. This proving impossible, he removed the mucous membrane piecemeal. The second case was that of a girl, suffering from congenital syphilis and bilateral dacryocystitis: the distended sacs were surrounded by much thickened subcutaneous tissue. In this case both sacs were removed by the procedure adopted in the first case. Some weeks later the scar on one side gave way and a lacrymal fistula resulted.

About the same time Hätter of Stuttgart had two cases; his operation differed from that of Berlin in one detail only. After opening the sac he packed it with sponge, and completed the removal twenty-four hours later. From this date, until the publication of Schreiber's paper in 1881, very little was done; Schreiber strongly advocated the performance of the operation in all cases of incurable dacryocystitis and lacrymal fistula. He described the method introduced by von Graefe, according to which the sac is dissected out without being opened.

After this paper, the operation was more frequently undertaken, especially in Germany.

There are two chief methods of procedure—through the conjunctiva and through the skin.

The former method is advocated by von Hoffmann (4), chiefly because of the freedom from hæmorrhage and the absence of a subsequent visible scar.

Van Hoffmann's Method of Extirpation

Instruments.—Weber's canaliculus knife, scalpel, dissecting forceps, curved blunt-pointed scissors, pressure forceps, retractors, needles and needle-holder.

First Stage.—The canaliculi are slit up and dissected from the lids as far as their junction with the sac; they are then seized in forceps and drawn forward, while a crescentic incision is made at the inner canthus at the junction of skin and

conjunctiva. This incision must be at least half an inch in length.

Second Stage. — A careful dissection must now be made behind the internal palpebral ligament to expose the sac. When the sac comes into view the knife may be laid aside, and the further dissection made with the scissors; after the sac has been carefully freed from the palpebral ligament in front, it can be drawn down and the dome freed by a few strokes of the scissors. Great care is then required to separate the posterior and inner wall from the bone. Finally the sac is pulled upwards and outwards, and divided as close as possible to its junction with the nasal duct.

The operation is much more difficult than von Hoffmann admits. It is true that in the dead subject a normal sac can be removed in this way easily enough, but in the case where removal is required in life, the tissues are much matted together, and removal even by an open method is difficult; how much more when the surgeon is working in the dark.

Removal by means of a Cutaneous Incision

Kuhnt (5), in 1888, recommended an incision commencing about 4 mm. above the internal palpebral ligament, and extending downwards for 20 or 25 mm. along the margin of the orbit.

Axenfeldt has made the operation less difficult by the introduction of two special retractors (which have been again modified by Lang), the smaller invented by himself and the larger by Müller. The latter are particularly useful in controlling the venous hæmorrhage, which may otherwise cause great inconvenience. Lang relies on the free use of adrenaline for the prevention of hæmorrhage.

Axenfeldt (6) calls his method "the subperiosteal method." It resembles that of Kuhnt, except that the incision is about 3 mm. in front of the lacrymal crest, in which line he elevates the divided periosteum and separates it from the bone as far back as the posterior crest. In this way he raises the lacrymal sac from its bony groove.

It is clear that if the infected upper part of the nasal duct be left, the wound is not likely to heal by first intention. Cirincione has modified the operation so as to include removal of the mucous membrane of the nasal duct.

Cirincione's (7) Method of Extirpating the Lachrymal Sac

Instruments.—Scalpel, dissecting forceps, curved blunt-pointed scissors, special bent knife, galvano-cautery, pressure forceps, needles and needle-holder.

First Stage.—The preliminary incision must be large. It must start about 1 cm. above the tendon oculi and pass downwards along the crest of the ascending process of the superior maxilla, finally curving outwards to the junction of the inner and middle third of the inferior border of the orbit. The whole length will be about 4 cm. By careful dissection from this incision the surgeon lays bare the anterior lacrymal crest, and separates the wall of the sac from the subjacent bone. All this dissection may be made with a scalpel.

Second Stage.—Then laying aside the knife, the surgeon isolates the dome of the sac and its orbital wall by means of the curved scissors.

Third Stage.—Next he divides the aponeurosis which fixes the sac to the bony orifice, by the special knife, and proceeds to separate the mucous canal from the periosteum; this part of the dissection is almost impossible without the special knife. The shaft of the knife is bent twice at a right angle, so that the blade is parallel with but a little distance from the plane of the handle. The edges are both cutting and the point is rounded.

By this knife the dissection is made. The canal, in disease, is often easily separable from the bony walls; in health, the execution of this part of the operation requires much care. The adhesion is usually closest along the antero-external wall.

Finally, when the whole canal is freed from its attachments, the mucous membrane is divided at the junction with the in-

ferior meatus of the nose, and the whole structure, sac and duct, drawn away together. Sometimes it is not possible to detach in this way all the canal; if the bony duct is small, the surgeon may succeed in removing the upper part only of the mucous membrane; in such a case he will destroy the remaining part by introducing a galvano-cautery.

Fourth Stage.—The canaliculi are closed by the cautery, if this is thought necessary; the wound on the face is sewn up, and a pressure bandage is applied.

Patients, after the removal of the lacrymal sac, rarely complain of epiphora, and more rarely the more complete the removal. This is somewhat surprising, since the physiologists would have us believe that the tears are, even under normal conditions, constantly flowing down the tear passages. There are two possible explanations. Either the lacrymal gland ceases to secrete normally after the removal of the duct, or the tears are not constantly flowing down the tear passages.

We are convinced that the latter is the true explanation, and that secretion occurs only under emotion, or after reflex irritation, chiefly through the first division of the fifth cranial nerve (*e.g.* exposure of the eye to a cold or hot draught, foreign bodies in the conjunctival sac, or inflammation of some part of the eye or adnexa).

There is still considerable doubt as to the exact innervation of the lacrymal gland. Certainly it is supplied by the fibres of the lacrymal branch of the ophthalmic division of the fifth cranial nerve, and also by the sympathetic nerves. It is probable that the fibres in the lacrymal nerve come really from the nucleus of the glosso-pharyngeal by means of the seventh nerve.

When patients who have undergone extirpation of the sac complain of watering, it will often be found that the removal has been incomplete, and that a small pouch of mucous membrane has been left in connection with the upper canaliculus; if this be obliterated, the lacrymation will usually stop.

Schultz (14) has attempted to prevent the infection of the

conjunctiva permanently, by destroying the mucous membrane of the canaliculi for a length of about 4 mm. with the galvano-cautery. After sealing the afferent passages in this way, he has found that the inflamed sac becomes quiet.

This is a much less serious proceeding than removal of the sac, but in our experience is not so uniformly successful as Schultz seems to have found it.

GROUP 4.—

REMOVAL OF THE LACRYMAL GLAND

This is one of the rare operations of ophthalmology. It may be required for two conditions—to stop secretion or to extirpate a focus of disease.

As regards the first of these, the epiphora may be the expression of true hypersecretion, the result of hypertrophy of the gland; it has been shown that the hypertrophy affects chiefly the palpebral portion, and removal of this part alone will suffice usually to stop the overflow. In other cases it is the result of obstruction, or irritation, and here the operation will only be employed after other means have proved ineffective.

Removal of the palpebral part is therefore usually undertaken first, since it is more easily accessible and the manipulations are simpler. It will often succeed, and if it fail, can be followed by removal of the orbital lobe.

REMOVAL OF THE PALPEBRAL PORTION

This operation may be done under cocaine, but sometimes a general anæsthetic will be required.

Instruments.—Scalpel, dissecting forceps, retractors, blunt-pointed scissors, pressure forceps, sharp hook, ligatures, needles and needle-holder.

First Stage.—The upper lid is everted and maintained in this position; the gland is now seen beneath the conjunctiva, in the outer third of the fornix; it is seized with forceps and drawn downwards.

Second Stage.—A horizontal incision about 10 mm. long is

made through the conjunctiva immediately above the forceps. Into this is passed the sharp hook, which transfixes the innermost part of the gland and drags it down into the wound. The forceps are loosed.

Third Stage.—By means of blunt-pointed scissors the gland is separated from its attachments on the inner side, above and below; since the vessels run into the lobe almost entirely from the outer side, there is very little bleeding during this dissection. When all these sides are freed, the gland is rotated outwards and its attachments on the outer side divided, behind the external lateral ligament. There is then pretty free hæmorrhage.

Fourth Stage.—The conjunctival wound may be sutured rapidly and firm pressure applied over the replaced lid.

Removal of the Orbital Portion of the Lacrymal Gland

This is a much more severe operation; a general anæsthetic is always necessary. The brow must be shaved and the skin made aseptic.

Instruments.—Scalpel, dissecting forceps, retractors, pressure forceps, rugine, blunt-pointed scissors, ligatures, needles and needle-holder.

First Stage.—An incision, 3 cm. in length, is made in the outer third of the upper orbital margin, through skin, orbicularis, and the underlying cellular tissue. The orbital fascia then becomes visible immediately below the orbital margin; this must be divided at the attachment to the periosteum and drawn downwards.

Second Stage.—The anterior edge of the gland, lying next to the fascia, in the shallow depression of the orbital roof, can now be seized in forceps. With the scissors the bands uniting the upper surface to the periosteum are divided; the body of the gland can now be drawn into the wound, and its further connections separated; the lacrymal artery, necessarily cut in this stage, will be ligatured. The freed gland is then removed.

Third Stage.—The orbital fascia should be replaced in position, the skin wound carefully sutured, and firm pressure applied.

Operations on the Bones of the Orbit and the Surrounding Sinuses

The problem of dealing with new growths, or inflammatory conditions far behind the eye, without interfering with the nervous mechanism of the eye, or the eye itself, has occupied the attention of ophthalmic surgeons for a long period. Any simple growth arising in the depths of the orbit will eventually, by pressure, destroy the usefulness of the eye. It is, therefore, a matter of urgency to remove such a growth before its size has increased to a dangerous point. It is an even more urgent matter to remove a malignant growth while it is yet localised, and while its ablation gives a fair hope of complete cure. Since such deep-seated neoplasms cannot be diagnosed with certainty, whether as to position or nature, from the front of the normal orbit, it was formerly always a very serious question, when the presence of a new growth was suspected, whether it would be necessary to remove the eye or not. To sacrifice a normal eye with normal vision, from fear of the nature of a tumour behind the eye, was a very serious matter, especially when the tumour might turn out to be non-malignant, or even a cyst. On the other hand, in the presence of a sarcoma, nothing but removal at the earliest stage could give any chance of cure. The obvious way of exploring the orbit, from the front, was only sufficiently roomy after removal of the eye. It is impossible to deal adequately with any post-ocular growth, working through the narrow space left between the eye and the orbital walls.

From this cause many eyes were sacrificed which might have been saved. It is laid down in some of the older works on ophthalmic surgery that there is no option but to remove the eye.

When later operators began to consider how the question might be better dealt with, the anatomical relations of the orbit pointed the only alternative way.

The bony cavity of the orbit is surrounded on three sides by

other cavities of the skull; below is the antrum of Highmore, on the inner side are the nasal meatus and the accessory sinuses, and above is the cranial cavity, separated in the inner part from the orbit by the frontal sinus.

If the surgeon were to attempt to enter the orbit from the inner or the lower side, he would clearly have to undertake extensive resection of bone, involving great after-deformity, and would place the orbital cavity into communication with the nasal passages or the mouth, a communication which would almost certainly occasion sepsis of the wound. Nor was the upper wall much more accessible; to enter the orbit from above necessitates the removal of the orbital surface of the frontal bone in greater or less part, and great disturbance of the dura mater and the brain.

Such an operation has been devised by Cahen and Franke. Cahen makes a temporary resection of a piece of the frontal bone and removes by chisel the upper wall of the orbit, pushing on one side the dura mater and the brain. This method seems unduly dangerous.

Franke's (8) plan is as follows: he makes a long incision in the line of the upper edge of the brow, curving down at the inner end to the level of the inner canthus. In making this incision the edge of the knife is directed rather upwards, so that the bone is laid bare 0·75 or 1·0 centimetre above the free border of the orbit. The bone is then cut through downwards with a broad chisel, and a flap of bone and skin is made, which can be displaced downwards. The orbital fascia is detached from the inner and upper walls, and the surgeon can then reach the depths of the cavity, even to the optic foramen.

If it is preferred, the flap may be displaced up- instead of downwards; it is rather more difficult to cut the bone in this case, and the space for examination is not so free; further, the resulting scar is more noticeable. For these reasons Franke recommends the former method.

There remains the outer wall: this, though rather deeply placed, at the bottom of the temporal fossa, is yet much more

open to attack, and has no important relations. The wound can easily be kept aseptic, and no great deformity need follow.

The credit for pointing out this route and laying down rules for the proper performance of the operation is due to Krönlein (9).

The outer wall of the orbit is made up of two bones, the orbital process of the malar and the great wing of the sphenoid. Above, it is separated in the posterior part, by the fissure of the sphenoid from the lesser wing of that bone and the orbital plate of the frontal, and in the anterior part is united to the frontal bone by a suture. Below, the posterior part is again separated from the adjacent wall by a fissure, the spheno-maxillary cleft, and the anterior part is continuous with the horizontal part of the malar bone. The wall is thus divisible into two parts—the posterior, for the most of its extent separated from the other walls by the fissures, and the anterior, limited in front at the external orbital margin, and united all round to the other bones, except at the extremity of the spheno-maxillary fissure. The operation concerns the anterior half only; the bony flap which is dislocated in the course of the proceeding consists almost wholly of the orbital process of the malar, together with the external angular process of the frontal bone. The orbital process has two surfaces: the internal, smooth and concave, is directed towards the orbit, and forms, as we have said, part of the outer wall; the external surface, almost vertical from above downwards, is deeply concave from side to side, and forms part of the temporal and the zygomatic fossæ, covered by the temporal muscle, which, however, is not attached to the bone in this region. The periosteum of the orbital surface is easily separable by the very slightest force from the underlying bone.

Krönlein's Operation

Instruments.—Scalpel, dissecting forceps, rugine, retractors, osteotome, mallet, if possible a small circular saw in a dental engine, pressure forceps, needles, with stout silk, needle-holder.

First Stage.—The surgeon makes a curved incision, with the convexity forwards and downwards, commencing about half an inch above the external angular process of the frontal bone, and terminating over the middle of the zygoma; the upper part of this incision follows the orbital margin. He gradually deepens this until it reaches the periosteum.

Second Stage.—He divides the periosteum along the orbital margin, and clears the orbital surface of the great wing of the sphenoid, pushing back the orbital periosteum with the rest of the contents of the orbit. The bone is now freely exposed.

Third Stage.—The surgeon now divides the bones in the following order (the incisions may be made with the osteotome, but the dental engine with the small saw will be found a great saving of labour if one be procurable). The first incision is through the base of the external angular process of the frontal; the second runs downwards and backwards from this, following roughly the orbito-malar suture, to reach the spheno-maxillary fissure; the third is directed through the base of the orbital process of the malar bone, horizontally backwards, to the anterior end of the same fissure. The flap now can be dislocated outwards, and the orbital periosteum which covered the great wing of the sphenoid is largely accessible.

Third Stage.—This periosteum is divided in a horizontal line, and thus the surgeon is able to introduce his finger into the orbit and explore its contents. If necessary, he will divide the external rectus muscle.

In dividing the bones, it is very important to keep the order here mentioned; if the malar be sawn through before the great wing is cut, the loss of support will make the oblique division difficult.

This operation is not infrequently followed by some permanent loss of power of one or other of the orbital muscles, which, if not already impaired by disease, are hurt during the exploration of the orbit. This paresis, therefore, is not really attributable to the operation, but at worst to the secondary manipulations, which may be necessary, but form no part of the operation as

here described. The external rectus alone can suffer in the process which has been here laid down.

Several modifications of varying value have been suggested to the present operation. Czermak removes the body of the malar bone as well as the orbital process. The modification seems to add to the difficulty, and but little to the advantages of the original.

Parinaud and Roche (10) try to avoid the appearance of the scar at the orbital margin by turning back a square flap of the soft parts from the temple to the orbital margin, and then sawing the bones.

Angelucci (11), at the Seventeenth Congress of the Italian Ophthalmological Society, held at Naples, October 1905, brought forward a modification of the operation which seems simple. He makes an incision through the soft parts, starting at the external angle of the orbit, and descending vertically to the base of the orbital process of the malar; this incision is about 4 cm. long. From the lower end of this, a second incision runs for 20 mm. along the upper border of the zygoma.

He divides the orbital process of the malar with a saw, below for a depth of about 6 mm., and above, following the line of the fronto-malar suture, for a depth of 2 or 3 mm. He then grasps the bone, after separating the periosteum from its entire internal surface, in cutting bone forceps, and, without exercising undue force, dislocates it outwards, producing a fracture along the line of the spheno-malar suture. This simplifies the division of the bone.

The Surrounding Sinuses

Of the sinuses surrounding the orbit, few come under the purview of the ophthalmic surgeon. Any one of them may, by disease, give rise to symptoms or secondary disorders affecting the eye or the surrounding parts, but for the most part the treatment of any such conditions is handed over to the rhinologist. The frontal sinus alone is generally regarded as belonging rather to the province of the ophthalmic than to that

of any other surgeon, because distension of the frontal sinus gives rise to changes in the position of the eye at an early stage, and the ocular symptoms are those which first cause the sufferer marked inconvenience.

Operations on the Frontal Sinus

The frontal sinus is not infrequently the seat of inflammation; the mucous membrane may take on a polypoid condition and block the infundibulum, the passage between the sinus and the nose; there will follow dull headache, often paroxysmal, and relieved by a discharge of fluid from the nose; sooner or later, the bone over the sinus is absorbed as a result of the pressure, an l a fluctuating swelling appears in the upper inner angle of the orbit, near the superciliary margin; the reason for this situation is that the bone is thinnest here. The contents of this swelling are often clear mucous, sometimes purulent; in the latter case the skin over the lump will be reddened and œdematous. If untreated, the pus points somewhere near the orbital margin and comes through the skin; the resulting fistula discharges for many weeks or months. When the contents are not purulent, the surgeon can often detect, even before the bone is completely absorbed, a faint fluctuation, with a sensation of crackling, owing to the thinning of the bone.

The treatment of this condition is by no means simple. The mucous membrane lining the cavity is usually diseased, and it is difficult to remove the diseased tissue and form a new passage down to the nose. If the sinus be merely opened, the discharge of fluid may go on indefinitely. Even if the sinus be laid open freely it is difficult to deal with every diverticulum, and the danger of a relapse is considerable.

Valude (12), in a recent paper, gives his opinion that the tendency of recent times has been towards unduly radical measures. It is customary now, he says, at the first sign of disturbance, to lay open the sinus freely, and very likely remove all the anterior wall. This, the operation of Kuhnt, is too drastic, and produces too obvious deformity for any but the most severe

and obstinate cases; and he himself (Valude) is accustomed to perform a much simpler and less formidable operation, which, nevertheless, often is followed by cure.

The following is his procedure: he shaves the eyebrow, and makes a curved incision about 2 inches long just below the orbital margin. Through this he searches for the fistulous opening into the sinus, which is almost always present, though commonly blocked in part by a mass of polypoid vegetation. He curettes the marginal mucous membrane and that of the cavity in the immediate neighbourhood, and closes the incision, putting in a drain at the inner angle for a few days; he lays stress on the disadvantage of drainage by the fronto-nasal passage.

When, on the other hand, there is no opening existent into the dilated sinus, he perforates the bone at the thinnest point, and deals as before with the cavity.

It is clear that this method is much less severe than that of Kuhnt, or even of Luc; and if, as Valude states, it succeeds in more than 50 per cent. of all cases, it deserves a trial, for even if it fails, or there is a recurrence of the disease at some later date, there is no increased difficulty in the performance of a more radical operation then.

The chief disadvantage of the more elaborate procedures, apart from their obvious severity, is that in many instances the removal of the bone interferes with the attachment of the pulley of the superior oblique muscle, and this disturbance is followed by troublesome diplopia. In certain cases this has not been permanent, but has gradually disappeared; in many, however, it has necessitated operative interference, to correct the altered muscular relations. Landolt has had remarkable success in such accidents by advancing the insertion of the inferior rectus muscle of the affected eye, and this would seem to be the best method of treatment; but it must be remembered that Jackson has had considerable success from an opposite operation, *i.e.* displacing the insertion of the superior rectus backwards.

Taking into account the fact that many cases undergo spon-

taneous improvement, or even complete recovery, it is well to be in no hurry to call in any active measures until it be seen that time alone will not suffice to bring about a cure.

Golowine's Operation

Golowine advises the surgeon to make the incision of the skin and bone in different positions; in this way he thinks we can avoid much depression of the scar. He removes a large piece of the anterior wall, and destroys the mucous membrane of the whole sinus by superheated steam.

Instruments.—Scalpel, dissecting forceps, mallet, chisels, elevator, steam spray.

First Stage.—The eyebrow being shaved, Golowine makes an incision about 5 cm. long, just above the brow, down to the periosteum, and from the inner end of this, a second, nearly vertical, incision to the same depth, following the line of the corrugator supercilii muscle. The triangle of soft parts above the horizontal incision is well raised by dissection, and the soft parts round the remaining incisions pushed back.

Second Stage.—He then marks out on the periosteum, which is laid bare, a semicircular flap, having the attached base downwards. The size of the flap varies with the size of the sinus. The periosteum is divided in this semicircle by the knife.

Third Stage.—He then cuts with a chisel a shallow groove extending down to the diploe along the line of divided periosteum, and with a second "thin, flat, and very wide" chisel, held obliquely, he loosens the flap of bone and turns it back, the undivided periosteum along the base serving as a hinge. This allows free inspection of the cavity, and the surgeon deals with the contents as seems best. If there is an external opening, Golowine drains by this, otherwise he carries a drain down to the nose.

He strongly recommends the use of peroxide of hydrogen as an antiseptic for the after-treatment. Occasionally he has at once disinfected the cavity and secured its obliteration by means

of a steam spray. Superheated steam is injected into the cavity for a short time, twenty seconds or half a minute.

There is a small danger of scalding the tissues around the wound, but this can be avoided with care, and the cure is permanent if the steam be efficiently applied.

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CHAPTER VII

CATARACT

Cataract, in one form or another, makes up a large proportion of all cases requiring operation on the globe of the eye. Vision demands the transparency of the refractive media; in cataract there is need of operation on account of the abnormal opacity of the lens. Perhaps in this term "cataract" we should include also opacities of the capsule, but such opacities must affect the capsule itself, and not merely be masses of lymph lying on the surface.

The lens is a mass of changed epithelial cells, derived primarily from the epiblast, and is in greater part made up of elongated fibres, which are arranged in well-defined layers and sectors. The whole mass is enclosed in a capsule. This capsule of the lens is a thin structureless membrane, thicker in front than behind, and about ·005 mm. in its thickest part, the centre of the anterior layer. It is highly elastic, rolling up away from any tear or opening that may be made in its continuity, and almost absolutely transparent in the normal condition.

Its origin is not certain; some authorities regard it as part of the mesoblast, but it is more generally accepted now as a cuticular secretion of the cells of the lens. This view is very strongly supported by the researches of Collins (1) into the origin of anterior polar cataract. The anterior layer is in contact in some part with the iris; elsewhere it is bathed by the aqueous humour. The posterior layer is in contact with the hyaloid membrane of the vitreous. It has been supposed by

some that the lens capsule was in absolute contact with the vitreous, and that there was no imtervening hyaloid, but the researches of Ovio (2), to which we shall again have to refer, seem to settle the matter positively in favour of the presence of the hyaloid.

Under the anterior layer of the capsule is a single stratum of cubical cells, closely adherent to it, which can be traced over the whole anterior surface of the lens, representing in reality the anterior layer of the primitive lens vesicle. When we follow these cells towards the equatorial regions of the lens, they may be seen gradually to change their character, and become, by elongation, the fibres of the lens. These cubical cells are of great importance, because they are the cells of active growth from which new fibres of the lens are developed throughout life.

Since they cannot be separated from the anterior capsule, new fibres may always be formed so long as this is present.

The lens, in young animals, and to a less degree as age advances, is extremely elastic, and is kept in a state of compression by the suspensory ligament. The curvature of the posterior surface is, to all intents and purposes, fixed (the radius being 6 mm.), and fills the postjacent fossa patellaris of the vitreous. The anterior surface is very changeable; with the accommodation at rest (the suspensory ligament being then in tension), the radius of curvature is about 10 mm., and the curvature fairly regular; when the ciliary muscle, by its contraction, relaxes the suspensory ligament, the surface becomes parabolic, and the curvature of the central region more abrupt. In old age the fibres of the lens are less elastic and do not respond readily to the alteration of tension in the ligament; accommodative efforts, therefore, bring about little or no change in the shape of the lens.

This loss of elasticity is shown anatomically by the presence of a nucleus, a compressed mass of fibres in the centre of the lens. The possession of a nucleus is taken as a means of dividing cataractous lenses into two classes—hard and soft. There is no real limit between the two classes, and the division

is only one of convenience; but since the entirely soft lens reacts very differently clinically to the hard lens, it is an important practical consideration.

Not all cataracts require operation; many forms remain unaltered for very long periods, and never interfere with useful vision to an appreciable extent. Even when vision is reduced considerably, it may be questionable whether an operation be desirable or not. Removal of the lens robs the patient of all power of accommodation. A young subject is probably better off with vision of one-third or one-fourth normal at both distant and near ranges than with normal vision attained only with the aid of a strong lens, and with no accommodative range.

When the question of operation has to be discussed, it usually means complete removal of the lens; very occasionally it may be possible to give good vision and retain the power of accommodation by making an artificial pupil, but this is most uncommon. The subject of optical iridectomy will be dealt with fully in a succeeding chapter. Here we shall have to study operations for the removal of the lens. No medical treatment has given any good result in the attempt to stop the development of cataract; lately the use of subconjunctival injections of potassium iodide has been suggested by Verderau (3) of Barcelona, but though his records look promising, they are too few to base opinion on. The treatment, therefore, remains entirely surgical. The object of all the procedures is to remove the opaque lens from the line of incoming light, either by displacing it or removing it from the eye.

We have said above that the clinical reaction of hard and soft lenses is different. With a soft lens, if an opening be made in the capsule, the aqueous will cause first breaking up and then absorption of the fibres, so that the whole lens may be absorbed as the result of a very small lesion of the capsule. In the case of a hard lens, the process of absorption is much slower and less complete; the hard nucleus resists, and must in most cases be removed *en masse* from the eye.

In soft cataracts, therefore, it suffices to break up the lens with some freedom to ensure a gradual absorption. In hard cataracts, *i.e.* in patients over middle life, removal is necessary.

From thirty to forty it is somewhat difficult to know which line to take; the lens often reacts very slowly to discission, and is not extracted easily, because of want of solidity. Fortunately such cases do not often call for the surgeon's assistance; congenital cataracts have been dealt with before this age, and senile cataract has not appeared.

The first and most obvious method of removal was to displace the lens into the vitreous, or to "couch" the cataract. It is a comparatively simple operation, which, owing to its incidental risk, has passed almost entirely out of use in England; but it is performed by the native quacks in India constantly, and in a very rough-and-ready fashion. The failures are numerous, but it has been shown that even in their cases more than half obtain such results as would be considered successful, and therefore depression has again been seriously considered of recent years as an operation of election when from any cause, or combination of causes, the risks of extraction are so heavy as to outweigh the probability of cure. In such cases the surgeon's task of decision is not easy; no case should be refused the benefit of extraction if he has one chance in three of success, and this confines the use of depression within narrow lines. Some cases, however, are suitable; it may fairly be tried in the insane, when after-treatment of the ordinary kind is impossible; in some cases of incurable dacryocystitis when infection of the corneal wound would be almost a certainty; and in certain general diseases, *e.g.* diffuse degeneration of the vessels, when one eye has been lost from hæmorrhage after the ordinary operation.

The result of couching is immediate; vision is restored, with a suitable glass, to the best possible degree as soon as the lens leaves the pupillary region. Unfortunately in many cases the loose lens sets up cyclitis, and the eye is lost from sundry complications.

The operation of couching may be performed in two ways—according to the place to which the lens is relegated; the lens may be either depressed into the vitreous or rotated backwards round its inferior attachment as an axis, so that its posterior surface is downward and its upper border posterior, an operation known as reclination.

It was usual, in the time when the operation was most used, to tear the lens capsule freely before displacing the lens; many modern writers rather neglect this point, which is of considerable importance.

If the lens be displaced in its capsule, there can be no absorption; if, on the other hand, the lens is delivered from the capsule before it is dislocated, the lens fibres will probably undergo absorption to a large extent in the course of time. In the former condition the lens remains permanently as a foreign body, lying on or near the ciliary processes, and capable of exciting inflammation in them. If it be absorbed, there is no mechanical irritation, and the late risks to the patient are less.

For this reason most of the older authorities, *e.g.* Mackenzie, disapprove of the corneal operation, and prefer to enter the needle with which they move the lens, through the sclerotic behind the region of the ciliary processes.

On the contrary, one of the most recent writers on this subject, Rodolfo del Castillo (4), is strongly in favour of the corneal path, on the ground that fewer important structures are wounded during this mode.

Bourgeois, of Rheims (5), displaces the lens without rupture of the capsule. He has performed the operation in several cases in which there was great risk of failure with the usual extraction, and prefers reclination to depression.

Having in view the fact that one of his early cases subsequently became blind from glaucoma, he advises anyone who contemplates this procedure to perform a small preventive iridectomy. In the second series of patients, on whom he operated after this plan, there were no failures, and he is

convinced that the iridectomy itself adds nothing to the risks. Bourgeois does not appear to have tried to divide the capsule.

Hulke (6), in the Bowman Lecture to the Ophthalmological Society, gave an account of the method which Bowman used. It is the same as that described by Mackenzie.

The Operations of Depression and Reclination

Instruments.—Speculum, fixation forceps, curved needle.

First Stage.—The patient being seated on a low chair, the surgeon introduces the needle through the conjunctiva and sclerotic on the outer side of the cornea, about 4 or 5 mm. behind the limbus. He carries the point backwards towards the centre of the posterior surface of the lens: there should be some mark on the needle to show when it has penetrated a sufficient depth.

He then turns the point against the lens capsule, and divides it freely, by vertical sweeps.

Second Stage.—Then he carries the needle round the inferior border of the lens, and brings it up on the anterior surface, into the pupillary area. Here he divides the anterior layer of the capsule in the same way.

Third Stage.—If he wishes to perform reclination of the lens, he then places the flat of the needle on its anterior surface, reaching the upper border, and, by raising the handle and drawing it towards himself, so that it ends by pointing up to his right shoulder, he makes the lens fall back into the vitreous with its anterior surface upward; if it show a tendency to rise again, it must be again pressed down.

The movement of the needle to effect depression is somewhat different, but since it seems agreed that this method is more dangerous, it is not necessary to describe it.

If the capsule be not torn, the latter part of the first and the whole of the second stage will be omitted.

Couching is clearly applicable to lenses of all ages, when from any reason no other operation is to be considered. No other form of operation is useful for all forms of cataract.

For soft lenses the method of election is by discission, and three or four operations are often required before the whole lens is absorbed.

Discission

Instruments.—Speculum, fixation forceps, and Bowman's stopped needle.

Of these the first two are not always necessary and may be absolutely disadvantageous in some instances. A child is often much frightened by the introduction of the speculum, and will fight against any further procedure. He will, however, usually allow the surgeon to separate the lids with the thumb and ring finger of the left hand, and to fix the globe, sufficiently for the purpose, with the index.

The surgeon can then introduce the needle, held like a pen, with the blade on the flat, through the sclero-corneal junction, until the point reaches the middle of the pupil. (If the needle is well ground, the lance head makes an incision just large enough to allow the shank to follow without force and without leaking of aqueous.)

Then he depresses the point and tears the lens capsule in the pupillary region. The needle is withdrawn on the flat; if care be not taken to keep the needle in this position, the wound is converted from a line to an L or T shape, which remains open longer and is more likely to be infected.

The amount of laceration to be inflicted at the first sitting is not easy to judge. It is better to do too little than too much. The risk of repeating a needling is very small. The aqueous will gain entrance to the lens substance through the hole in the capsule, and will cause swelling of the lens, which, if extreme, may give rise to an attack of acute glaucoma within a few hours. This will necessitate further interference at once.

When a small opening only is made in the capsule, a little mass of the lens matter swells up and comes forward into the anterior chamber. Here it is absorbed, and its place taken by another quantity.

In some cases this goes on until the whole lens is absorbed through a small puncture, leaving only wrinkled capsule behind. More commonly the process of absorption goes some distance and then stops, and a second needling has to be undertaken. This may, under these circumstances, usually be more extensive than the first. If much lens matter come forward and the tension rise, the contents of the anterior chamber must be evacuated through a corneal incision, either by a curette or by suction. The latter method has lately been in undeserved disfavour; certainly the old models of suction tube were objectionable, since they could not be efficiently sterilised; if one is used made entirely of glass or silver, and the suction be

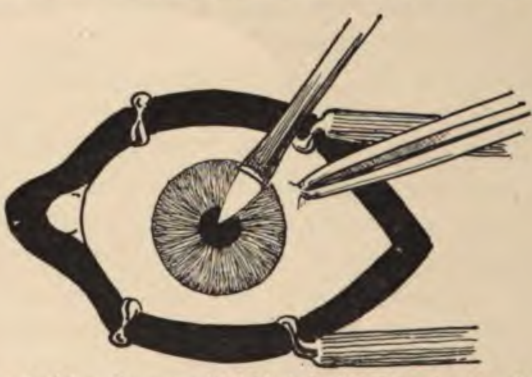

FIG. 94.—Incision of cornea with iridesis knife. Introduction of the blade.

made by some mechanism and not by the mouth, there is less objection to the operation.

Instruments.—Speculum, fixation forceps, iridesis knife or keratome, suction or simple curette, and spatula.

First Stage.—The making of the incision will vary with the choice of the knife. If the surgeon elect to use the iridesis knife, he will seize the conjunctiva and Tenon's capsule near the left upper quadrant of the cornea, and introduce the knife just within the cornea midway between the horizontal and vertical meridia. He will then enlarge the wound to the required extent by cutting away from the forceps as he withdraws the blade.

Second Stage.—The free gush of aqueous following the incision often carries much of the broken-down lens out of the eye, but it is usually necessary to evacuate more. If the suction curette be used, this may be passed into the chamber and the fragments of the lens drawn into it.

Should the surgeon prefer the ordinary curette, much of the soft matter may be coaxed out without introducing the instrument into the anterior chamber at all, by depressing with it the posterior lip of the wound; occasionally the lens will be entirely evacuated in this simple way, but often some fragments will remain visible in the anterior chamber. It will then be

FIG. 95.—Use of iridesis knife. Enlarging the incision.

necessary to introduce a curette into the wound, and it is well to use one which has not been in contact with the tissues. The fragments will often escape down the groove; should they resist, slight massage with a second curette over the cornea usually drives them out.

Prolapse of the iris, though not common, is an occasional accident during this operation. The extruded part must be carefully replaced with the repositor; if it repeatedly prolapse, and will not remain in the anterior chamber, it must be cut off.

To minimise the importance of this risk, the corneal incision should be made in the upper part, since, if a prolapse of iris occur, it is attended with least disadvantage here.

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When the whole lens is absorbed, the wrinkled capsule lined with a few cells may need further treatment. It is usually easy to tear a large hole in it by means of two needles (Bowman's method, *q.v.*).

Some surgeons treat lamellar cataract by needling only, without evacuation. The process of absorption then extends over many weeks. Others evacuate soft lenses through a large incision, made with a keratome, or lance, deep into the lens, without preliminary needling.

Senile Cataract

The course of development of senile cataract is often very slow, so that the sufferer is disabled from all work for many months, or even years, while the lens is gradually becoming ready for operation. If this time of waiting could be shortened, it would be greatly to the advantage of the patient; since aseptic methods have been regularly employed, it has been less necessary to wait absolute maturity, but still the period of waiting is long and irksome.

Artificial Maturation

Several devices have been suggested to hasten the maturation of the opacity: it is one of the advantages of a preliminary iridectomy that the lens becomes, in many instances at least, rapidly more opaque after its performance, but the progress is not universal.

An early method to secure artificial ripening of the cataract was that of Mooren, who pricked the anterior capsule with a needle. This procedure, although it is sometimes followed by the desired result, is not infrequently unsuccessful; sometimes no apparent effect follows, sometimes there is threatening of disaster from the excessive swelling of the wounded lens, which produces secondary glaucoma.

Later Förster (7) suggested the performance of an iridectomy and light massage of the anterior surface of the lens through the intervening cornea, by means of a curette. Others suppressed

the iridectomy, and after evacuation of the contents of the aqueous chamber, massaged the lens with more or less vigour. Panas recommended that this massage should be applied through the upper lid.

Snellen and others, on the other hand, thinking that the rubbing was likely to set up inflammation of the iris, employed iridectomy only. With all these methods some success was obtained, but there was still considerable uncertainty as to the result.

The failure was attributed by many surgeons to the insufficiency of the massage, which they thought had not been applied with adequate force. They (8) therefore recommended that the surface of the capsule should be rubbed directly without the interposition of anything.

This method, while more certain as judged from experimental work in the laboratory, was found not seldom to set up, in the human eye, severe iritis, and therefore the "immediate massage of the capsule" has never acquired many supporters.

Nor is massage, combined with simple or multiple puncture of the capsule, less free from grave objection.

Jocqs (9) has recently advised a somewhat different plan to render a lens opaque. This he adopts only in cases of high myopia, in which he intends to remove the lens; he does not recommend it in the case of lenses in which there is a well-marked nucleus, and therefore it is not really applicable, in his judgment, to senile cataract. He introduces the needle of a special syringe into the anterior chamber, and draws a little of the aqueous into the previously empty barrel. Then plunging the needle deeply into the centre of the lens, he injects the fluid there. Opacification follows rapidly.

It seems clear that none of these proceedings are entirely unobjectionable; the massage may set up iritis, because the iris is inevitably bruised, even though the pupil be dilated as a preliminary step; and, further, the capsule of the lens may be ruptured by too forcible rubbing.

The method most generally adopted now, if artificial matura-

tion be decided on, is some form of massage, combined with a preliminary iridectomy. The rubbing should be applied through the cornea, its employment directly to the lens is too hazardous; a sudden unexpected movement on the part of the patient may easily give rise to dislocation, an accident which can hardly occur if the cornea interpose between the rubbing instrument and the capsule.

It is generally considered that opening the capsule of the lens is adding a grave risk, without sufficient compensating advantages, though there can be no doubt that the lens changes much more rapidly after such a manœuvre.

The mechanism of these procedures has been examined by Demaria (10), who has shown that the immediate result of the massage is to produce a desquamation of the cells lining the anterior capsule in the part where the massage is applied. When the epithelial cells fail, the capsule alone is unable to prevent the passage of the aqueous into the lens and the fibres break up as in a traumatic cataract.

Demaria considers any opening of the capsule as a most unfortunate accident or as a most improper proceeding. Properly performed, he says the massage cannot give rise to rupture of the capsule, and yet it is able to cause the entrance of a sufficient amount of the aqueous to cause the cells underlying the capsule to become opaque. He lays great stress on the risk of glaucoma as a result of excessive swelling of the lens fibres, and therefore condemns absolutely the method of Jocqs, which we have just mentioned, though he does not seem to have noticed the limitations which Jocqs laid down for its use.

Demaria, in his experiments, made use of immediate massage, and rubbed the surface of the capsule for three or four minutes; if the massage be made with the cornea intervening, the rubbing must be more prolonged—probably ten minutes is not excessive. It should affect especially the central region of the capsule, and the extreme lateral parts should be avoided.

It is a common sequel to see the pupil covered with a layer of lymph, the sign of an iritis. This inflammation lasts only

two or three days, and never, in Demaria's experiments, led to suppuration.

Within twelve hours of the operation there appears a greyish discoloration of the lens in the pupillary region, affecting the anterior cortical substance. In the rabbit, on whom Demaria performed his operations, the opacity was specially marked in the junction of the fibres. Gradually it spread to the whole anterior surface of the lens.

At this stage the anterior chamber became shallow, showing that the lens was swollen. Still later, the posterior cortex shared in the process. In none of Demaria's experiments was there any recession; the opacity, if it did not advance after twelve hours, never retreated.

Demaria made careful records of the weight of the lens which had undergone massage and compared it with that of the lens of the opposite side; there was a great increase of weight immediately after the operation, the difference amounting in some instances to as much as 160 milligrams, and this could only be attributable to the entrance of the aqueous.

Lately (September 1904) Wolffberg (11) has published a paper describing a method of bringing about the desired maturity totally different to those just enumerated, in that it calls for no corneal or other wound.

Remembering how frequent is cataract among workers in glass, who are exposed to high temperatures, Wolffberg employs heat to mature the partially opaque lens. He first made use of it after a preliminary iridectomy had failed to bring about maturity, but the excision of the iris seems quite unnecessary.

For the treatment a special apparatus is needed; a blast of air is forced through the flame of a spirit lamp, issuing through a cylinder at a temperature of about 100° C.

At a distance of 5 cm. from the end of the tube the temperature is about 80° C., at 10 cm. about 70° C.

The patient's mouth must be protected by a shield of damp wadding. Then the hot air, at about 70° C., is directed first on the forehead and then on the eye. When it is turned on this

organ, the patient cannot, by any effort of will, prevent it from closing. The skin blushes, and the redness remains for several hours after the cessation of the hot air douche: the eye streams with tears during the application, but the flow ceases with the removal of the heat. The conjunctiva is intensely injected, the cornea remains bright.

Should there be much pain, the apparatus may be withdrawn a few centimetres; this will lower the temperature. The sitting should last five minutes, the heat being applied to the eye for about a quarter or half a minute, and then removed for a similar interval.

If two or three sittings are borne every day, the ripening of the cataract will be accomplished within eight days.

Removal of Senile Cataract

In the operation of removal of the opaque lens there are many points which demand discussion, and, before dealing with any single method, we must say a few words on the more important of these.

The Incision

The primary incision of the globe, to allow the escape of the lens, has, like all the other details of the operation, been the subject of much discussion, and the seat of many modifications both as regards position and extent.

The position may be regarded, now, as fixed within very narrow limits. Almost all now would choose the upper part of the sclero-corneal zone in which to place the section, unless from some accident this were unavailable.

If the section be made above, the wound is covered by the upper lid, and the lower part of the cornea, which is exposed, is not interfered with by the operation. A prolapse of the iris would greatly disturb vision, if the section were made below; if above, it may be followed by the recovery of normal vision.

In the early times the section was made entirely corneal, and a flap of at least half the cornea was cut. The idea of

making the section in the cornea was, that the corneal wound healed more readily. This is certainly not the case. Placing the incision in clear cornea necessitated an enormous flap to allow the escape of the lens. This large flap, badly nourished, often sloughed, and then the eye was lost. Von Graefe, to avoid the necessity for so large a flap, devised his linear section, the wound being an arc of a great circle, and, therefore, lying in a plane cutting the centre of the globe.

This placing brought the extremities of the wound rather near the ciliary region, and for this reason it was modified so as to be a little less linear, and to have a small curve, marking out a flap about 3 mm. high: the wound thus becomes a segment of a circle larger than the cornea—the ends lie about 1 mm. outside clear cornea, and the centre of the incision coincides with the apparent sclero-corneal junction. Some surgeons make the whole incision in the apparent junction. Whichever of these two situations be chosen, the incision is really corneal; for the cornea is overlapped on its outer surface by the sclera and conjunctiva for about 2 mm.

The size will vary slightly with the estimated size of the nucleus. Generally speaking, if we complete mentally the circle in which the puncture and counter-puncture lie, concentrically with the cornea, about one-third of the circumference will be included between these two points.

For certain conditions—if, for example, we think the nucleus to be unusually hard and large, or if we expect the vitreous to be fluid, and wish, for this or other reason, that the lens should be expressed with as little force as possible—the incision may be made rather larger by bringing the extremities lower.

A few surgeons have made, from time to time, eccentric incisions, which deserve mention only from historical interest. Thus Kuchler at one time made a horizontal incision directly across the cornea; it was fundamentally faulty, since the scar was in the least favourable position both as regards the visual result and as regards prolapse of the iris. Liebreich and Warlomont practised incisions midway between the horizontal

line and the limbus, the former cutting rather downward and the latter upward. Neither of these methods has stood the test of time. Recently Mulrooney has achieved very good results in India by a peculiar operation in which he makes the section downwards. The disadvantages which have been already enumerated against this position seem to the authors by far to outweigh any convenience which the lower section gives at the time of operation, and, therefore, they adhere to the opinion given in the preceding paragraph, that no one should choose the lower section if the upper is possible.

To secure the most speedy healing of the wound, various expedients have been suggested. One of the most successful is to modify the incision so as to make a flap of conjunctiva adhering to the cornea. This is done by carrying the plane of the section just behind the margin of clear cornea; then by turning the knife backwards as it emerges, the conjunctiva is divided farther back than the sclero-corneal tissue (12). Such a conjunctival flap adheres very rapidly, and seems to be of considerable assistance in securing the wound against the intrusion of micro-organisms.

Other surgeons have attempted to unite the wound by sutures, as it would naturally be expected, on theoretical grounds, that such a proceeding would favour immediate union. Practically it has not been found that suturing bears out this theory, and sutures are seldom, if ever, put into the cornea. A few operators suture the conjunctival flap. The adhesion of this is so rapid that sutures are of little value here. Maddox (13) has recently given the results of some experiments, which he has made in the search for some substance to act as a cement for the wound. In one instance he was able to apply a dressing of newly-melted wax, under which the wound healed rapidly. Unfortunately he has failed in the majority of instances to gain this end by means of wax, which has little adhesive power; and a prolonged search has not enabled him to discover any body which sets with sufficient quickness on a moist surface.

The question of sutures, applied to a conjunctival flap, merits

more examination; as will be shown in a later paragraph, the result of a cataract extraction depends in large measure on the rapid and permanent closure of the wound. There is little doubt that a wound with a conjunctival flap, held by sutures, is less likely to reopen than a simple corneal flap; and from this, as will be shown, less after-cataract is to be expected.

Generally speaking, the advocates of the "combined operation" make the modified linear incision, which will be described as the operation of election. The surgeons who perform the simple extraction choose either the modified linear, with a short conjunctival flap, or, as followers of de Wecker, place the wound at or within the sclero-corneal junction.

As regards the position of the operator, it is necessary to say a few words. Most English surgeons stand behind the patient on all occasions, and, studying ambidexterity, hold the knife in the right hand when operating on the right eye and in the left hand for a left-sided cataract. A few have special bent knives, which allow them, while standing in the usual position, to make a section of the left eye with the right hand. On the Continent, however, it seems the general rule to use the right hand always, and the surgeon therefore stands in front of the patient when attacking the left eye, and cuts away from himself. The difficulty of ambidexterity, as far as making a section with the left hand, has been exaggerated; in any ophthalmic operation the hands must work in concert, now holding forceps, now cutting instruments, and this training is all that they require.

In describing the section of the globe, stress is naturally laid on the external opening; this is the most obvious means that we have of judging the condition of the really important internal mouth of the wound (14). Most operators attempt to make their wound almost if not entirely in one plane. The knife rarely travels in such a simple course, and if the wound be examined in an eye which has been enucleated at any period after extraction, the observer will find that it is usually curved in section, with the concavity forwards (15), or else is made up of two parts, joining at an obtuse angle.

Iridectomy

If the question of the position and extent of the corneal wound may be considered settled, this can not be said about the performance of iridectomy as a routine part of the operation of extraction.

The original method did not include iridectomy; this was an addition of the middle of the nineteenth century, and is owed largely to von Graefe: before his time the chief causes of failure were sloughing of the cornea and inflammation or prolapse of the iris: he noticed that the inflammation almost always began at the part of the iris opposite the centre of the wound, and suggested that if this part were removed, the inflammation could not occur. Mooren, a pupil of von Graefe, was the first to carry this suggestion into effect; he removed, by a preliminary iridectomy, the part of the iris opposite the future cataract wound, and extracted the lens at a later date. His results were far better than those of the majority of operators in his day, and aroused general disbelief.

Since then, surgeons have been divided into the upholders of the simple and of the combined operation. Both have certain advantages.

The simple extraction, without iridectomy, leaves the eye practically normal in appearance, with a round, active pupil which is able to perform all the normal functions, both in relation to light and convergence. Nor is this all: the presence of the circle of the iris prevents prolapse of the capsule, an accident, as we shall see, responsible for many disasters after the combined extraction.

On the other hand, the combined operation prevents in large measure prolapse of the iris, and, at least in the older days, inflammation of this part. Modern improvements in the preliminary preparation of the eye and in the details of procedure have largely reduced the percentage of cases in which severe iritis comes on after any operation.

If we consider the various points a little more closely, it

becomes obvious that the advantages of a round pupil are mostly apparent; when a narrow iridectomy has been made, the coloboma is hidden almost completely by the upper lid, and thus the deformity of the pupil is hardly noticeable.

The contraction of the pupil to convergence is probably only of value by its action of stopping out the periphery of the lens, since in accommodation, the anterior surface becomes very unevenly curved. Inasmuch as the cornea is more regular, this action is less necessary after removal of the lens.

The reaction to light, however, is of real importance to enable the eye to adapt itself rapidly to variations of illumination, and this power is largely destroyed by the division of the sphincter iridis. The pupil acts slightly only after the combined operation, but, on the other hand, after simple extraction it is by no means rare to find the pupil tied down in one or more points by adhesion to the capsule as a result of very slight iritis. The question of prolapse, either of the iris or of the capsule, is much more serious. Prolapse of the iris may occur either at the time of operation or within the first few days of healing. Prolapse occurring at the time, "immediate" prolapse, can be dealt with by replacement; sometimes the iris seems paralysed, from the stretching which it has undergone during the expression of the lens, and refuses to remain within the eye, but again prolapses as soon as replaced. Then, in any case, the surgeon will perform iridectomy. On the other hand, prolapse may occur later; the wound for extraction rarely heals without an occasional opening during the first twenty-four or forty-eight hours, an opening noted by the patient as a gush of fluid from the eye, and one such may carry the iris out into the wound. Such a prolapse will not, in all likelihood, be discovered by the surgeon for some time after it has happened, and a secondary operation will be necessary to relieve the patient from a dangerous and painful complication.

The number of cases in which this secondary prolapse is seen varies with the operator: probably it will be between 5 and 10 per cent. It is not, therefore, a very frequent complication, but

its dangers are so real that even this small number weighs heavily against the advantages which we have already conceded.

Further, an iridectomy performed at the time of extraction is not so favourable as when the two are separated by an interval; there seems no doubt that a mixture of blood and lens matter in aqueous is a more suitable material for the growth of pyogenic organisms than a solution of either separately. Hence the results are a little worse when the iridectomy is performed at the same time as extraction.

Prolapse of the capsule, which is undoubtedly more frequent when the circle of the iris is broken, can be guarded against with practical certainty, as we shall see later, by care in incising the capsule; this advantage, therefore, though real, is not of such importance as the security against prolapse of the iris.

If the idea be correct that the prolapse of the iris is due to the gush of fluid from the anterior chamber when the wound reopens, it would be possible to combine all advantages of the two operations by making an opening in the upper part of the iris, opposite the corneal wound, leaving the sphincter of the pupil uncut. This would prevent any accumulation of the fluid behind the iris, and consequently, when the wound opens, the gush will not carry out the iris; at the same time, the advantages accompanying the round pupil will be retained.

Several surgeons have sought to solve the problem in some such way; Bell Taylor, of Nottingham, at one time made a peripheral incision through the iris, and expressed the lens along this route.

Others (16) have made a buttonhole of more or less size in the iris, leaving the sphincter intact; the lens is expressed either through the hole, if it be large, or through the pupil if the hole be small. Not infrequently the bridge of tissue left is torn through during the passage of the lens; this does not seem to interfere with healing, though it reduces the operation to the combined operation.

Manolescu, instead of performing iridectomy, divides the iris radially, having drawn it out of the eye. This seems to expose

the iris to the risk of considerable bruising from the grasp of the forceps, and is not compensated by any special advantage.

Although the upholders of the simple operation are often loud in its praise, their arguments are not convincing. And, indeed, they themselves seem aware of their weakness, for one and all confess that they would choose the separated combined operation, *i.e.* extraction at an interval after a preceding iridectomy, in any case in which they wish to run as few risks as possible—if, for example, there is only one eye. Now it can be no valid reason, as it seems to us, that the surgeon should allow his patient to run an excessive risk, because with two eyes the risk of total blindness is less if the operation fail.

Opening the Capsule

The opening of the capsule has received an amount of attention in the recent years which it has hardly deserved; it would seem at first sight, in itself, the easiest part of the operation, requiring no force, and simple armament, and the long discussions which have filled the journals are based, as we think, on a misapprehension of the requirements of the case.

There are two points which must be carefully borne in mind when the surgeon has to open the capsule of the lens:

1. To leave no flap or tag of capsule which can turn back and either prolapse or become adherent to the wound.
2. To remove the anterior capsule from the pupillary area.

Of these two, the former is by far the more important, and the flood of discussion results from the failure to recognise this fact.

The researches of Treacher Collins (1) have shown that in many cases non-success of the operation of cataract extraction is due to such adhesion, by blocking the iritic angle, and giving rise to glaucoma from retention, or by entanglement in the wound preventing immediate union, and giving occasion to severe irido-cyclitis and sometimes sympathetic inflammation.

Probably the majority of cases of severe and prolonged inflammation after cataract extraction, especially those in

which the tension remains low, owe their non-success to the presence of capsule in the wound. Not only does the drag on the capsule disturb the ciliary body, but also the mere presence of a foreign body in the wound, by delaying healing, gives more opportunity for the entrance of septic micro-organisms.

On the other hand, adhesion without definite prolapse of the capsule, while not interfering actively with the union of the parts, tends to lift the base of the iris forwards, and thus favours the condition in which the escape of fluid from the eye is prevented and glaucoma occasioned.

It is easier for the capsule to prolapse if there have been iridectomy. When the whole iris is left, no tag of capsule can come near the wound except by unusual accident; this is one point in favour of simple extraction. It is, however, easy to prevent, in most instances, prolapse of capsule, or to reduce it by spatula, if it has occurred, at the time of operation. If the wound be not carefully investigated, as a routine measure, the transparent prolapse may be overlooked, and later its reduction is very difficult.

Swanzy recommends (17) that the capsule should be sought for with forceps, and drawn out of the wound; it seems rather more difficult to ensure thus, the complete freedom of wound and capsule, than by careful manipulation with the repositor.

With regard to the second point, the intention of removing the capsule from the pupillary area is to avoid the occurrence of after-cataract and the necessity of a second intervention of the surgeon.

The operation of needling an after-cataract is not devoid of risk, although the danger has been overstated by certain authors, and, if any method of opening the capsule could infallibly prevent the onset of after-cataract, there would be no question as to the propriety of its adoption. It is found, however, that a secondary operation is sometimes called for, in those cases where the anterior capsule has been removed with the greatest care and completeness, and even when the lens has been extracted capsule and all, in the scoop.

Pathological examination has shown the explanation of this fact; the after-cataract or "capsule," as it is not infrequently called, is made up from various factors. The capsule itself, both the anterior and posterior layers, is transparent in the normal condition, and unless altered by degeneration, is practically invisible at the time of operation; since it is transparent, it can only interfere with vision after the operation, if it become changed in some way or another; if it become wrinkled, it will seriously interfere with the acuity of vision, even though its transparency remain unimpaired.

Removal of a part of the anterior capsule has been recognised as a procedure occasionally to be adopted from the time of Daviel onwards; but it was, at first at least, only made a part of the operation of extraction, when the capsule itself was seen to be opaque. In all other cases the capsule was merely incised with sufficient freedom to allow the escape of the lens.

If, however, the lens is removed from the capsule by means of a simple peripheral incision, so that the two layers of the capsule are left to fall together, it is extremely probable that they will interfere with vision so far as to render a second operation necessary. Not only the capsule itself remains, but also a layer of cubical cells lines the anterior half, and these cells, proliferating, make a considerable mass in the way of the entering light. Hence surgeons for many years have tried to remove, in some way or another, the anterior capsule, at least from the pupillary area, either by incising it in such fashion that the fragments roll or fall away from the central space, or by actually removing that part which is most likely to interrupt useful vision.

But although it is not a matter of great difficulty to devise a plan to ensure the absence of the anterior capsule from the pupillary area, no one procedure has achieved general acceptance, and this alone proves that the removal is not able to ensure good acuity.

The pathology of after-cataract will be dealt with more fully hereafter. Let it suffice here to say that Wagenmann's

researches have clearly proved the possibility of the appearance of after-cataract, when the anterior capsule has been removed, almost completely, by avulsion.

It follows, therefore, that no method of opening the capsule can act as a sure preventive of the appearance of a membrane in the pupil, although its ablation will diminish the density of the following veil. Methods of opening, on the other hand, which ensure the absence of the anterior capsule from the pupillary area, do not always prevent its adhesion to the wound; any plan which fails in this respect must be rejected absolutely.

There are three methods of opening the capsule:

(*a*) By the cataract knife, during the incision for extraction.

In this method the point of the knife is made to perforate the anterior capsule soon after the puncture, at a point near the outer edge of the pupil, and carried on under the capsule for a distance of some millimetres, finally emerging near the inner border of the pupil. It is advisable to make the puncture and counter-puncture in the capsule as low as possible; the direction of the knife, therefore, should be rather downwards during this part of its course. As the knife is brought up to the horizontal line, to make the counter-puncture in the cornea, it cuts a semicircular flap of capsule, which, remaining attached to the capsule below, falls down away from the pupil. The chief advantage of this method is that it reduces the number of instruments passed into the eye during the operation: since the cystitome may be sterilised with certainty and without damage, by heat, this advantage is not great.

(*b*) By the cystitome.

This is the commonest method, but its use has many varieties Some surgeons make a single incision of some length in the upper part of the capsule, more or less concentric with the margin. This fulfils one of the indications, since neither the lower edge nor the upper can easily come into contact with the wound. The second, however, it ignores. The two layers of capsule fall into contact and can hardly fail to form a dense

after-cataract. A long vertical median incision is better. This allows the easy escape of the lens, and is not liable to be followed by prolapse; further, the rolling up of the margins carries the anterior layer away from the pupillary area. Some combine these two incisions.

Other surgeons have increased the retraction by making a cruciform incision; this is bad, because it leaves two triangles which may easily prolapse, and if the cross-cut is made diagonally, the liability is greater.

Others, again, try to arrange the incisions in such a way that they isolate an area of capsule, which will fall away from the pupil, as when the capsule is opened by the knife. For this purpose two cuts should be made, separate below and converging above; it is difficult to prevent this degenerating into a diagonal cross. The evils of this we have just pointed out.

Others entirely separate a piece of capsule by their cuts, and attempt to remove it with the lens. The part separated may be triangular, circular, or of any other form. Practically, a triangle with the apex downwards, and the base curved concentrically with the lens margin, is the most convenient.

The danger of this method is, that the triangular flap may be left in the wound, either being incompletely separated or being wiped off as the lens emerges.

(*c*) In the third form the capsule is torn away from the lens by forceps before the lens is expressed.

For this, special forms of forceps have been described by various surgeons—Forster, de Wecker, and Terson.

The second is practically a double cystitome, with which a flap of capsule is first isolated and then removed.

The third differs in several respects from any other forceps; it has the convexity of the lower part forwards, so as to fit the curvature of the posterior surface of the cornea, the teeth extend a little below the curve, and there is a stop placed between the blades, in such a position that the iris cannot be held when the teeth take hold of the capsule.

The following is the procedure devised by Terson (18). The

appearance of the capsule must be studied by oblique illumination with dilated pupil. If the capsule shows no markings, it is regarded as normal; if there are markings visible, as diseased. When normal, the forceps are passed closed to the lowest part of the pupil, and there allowed to open sufficiently to take a good grasp of the capsule; then the teeth are pressed into the capsule and the forceps closed sharply with a slight drag. When once the capsule is seized, Terson recommends that the forceps be drawn slowly upwards, with slight movements from side to side. The handling in seizing the capsule must be delicate; if rough, the lens may be dislocated and a gush of vitreous will follow. When, from the visible markings on it, the surgeon has reason to think the capsule thickened, Terson advises him to make a preliminary incision with the cystitome in the lower part of the pupil, so as to liberate the capsule here; this facilitates the after-removal.

Treacher Collins (19) states that with a method similar to this he is able to avoid the need of a second operation (for after-cataract) in at least 90 per cent. of all cases (British Medical Association Meeting of 1905).

There would seem no doubt that this last is the most certain mode of removing the capsule from the whole pupillary area, but unless the operator is possessed of more than ordinary delicacy of touch, there is some risk of dislocating the lens into the vitreous, by rupturing the zonule when the capsule is seized. For this reason, the authors would advise beginners to use the cystitome until they have gained the necessary skill.

Removal of the Lens

As to the actual removal of the lens, it is now practically always effected by external manipulations, unless the vitreous is presenting. There were, towards the middle of the last century, many surgeons who devised more or less ingenious instruments by which the lens could be dragged out of the eye. These took two main forms: some were hooks which caught hold of the anterior surface of the lens, others were spoons which

were passed behind the nucleus of the lens and lifted it out of the wound. Both these were faulty in principle; the former often depressed the lens back into the vitreous, the latter damaged the vitreous body and frequently set up severe inflammation there.

The only instrument of this type which has survived is the wire vectis of Bell Taylor. On occasion this is of great assistance. It is true that the traction spoons were intended, for the most part, to pass between the nucleus and the posterior capsule, but this latter is so thin and delicate that it is almost impossible to avoid rupture of this and damage of the vitreous.

It is important to remove the lens in its entirety whenever possible, not only because no after-operation will be required, but also because the presence of hard fragments of the lens seems to excite iritis in many instances. For this reason M'Keown (20) recommended irrigation of the aqueous chambers after removal of the nucleus, and claimed that by its use he was able to avoid the formation of after-cataract, and also to ward off the attacks of iritis which occasionally follow the ordinary method of removal. He described a syringe with special nozzles which could be introduced into the anterior chamber to direct a stream of water in any required direction. The method never gained many adherents, partly because the general results of the operation without irrigation are good, partly because of the desire to avoid the introduction of any instrument, which can be deemed superfluous, into the eye. This last objection has little weight since the adoption of aseptic methods. The syringe is not entirely satisfactory; it would be better, probably, to attach the nozzle of M'Keown to an ordinary irrigation apparatus or to an irrigating flask, which can be boiled before use and allowed to cool. Some surgeons use a flask into which sterilised air may be compressed over the contained fluid and regulate the force of the issuing jet in this way. There seems little or no advantage over the syphon irrigator.

Lately M'Keown's method has won friends in America.

The toilet of the wound is a matter of great importance for the result of the operation; no foreign body must be left lying in the mouth of the wound. We have already pointed out the evil which may follow prolapse of iris or capsule; all such prolapse must be carefully replaced, and the conjunctival flap smoothed out, if one have been made, before the bandage is applied.

From what has been already said, it is clear that the ideally perfect operation for cataract would remove the lens and capsule without disturbing or injuring the vitreous.

Brudenell Carter (21) long ago pointed out that this is sometimes possible. He says: "In some cases of perfectly mature cataract in aged people, the capsule of the lens is stronger and more resisting than its attachment to the zonule of Zinn. When this is so, the lens and capsule may be removed together, with the capsule unbroken, and in cataracts of the kind referred to, it is always worth while to make the external wound rather longer than usual, and, after the iridectomy, to see whether the lens and capsule cannot both be extruded by gentle pressure. If this can be done, the eye is left in the best possible state for rapid and perfect union of the incision."

We have, in an earlier connection, mentioned the researches of Ovio, on the nature and arrangement of the capsule and the zonule; these were undertaken to demonstrate the mechanism of the operation of Professor Gradenigo, which was designed to effect the end which we have just characterised as the ideal aim of cataract extraction.

But whereas Gradenigo makes a careful division of the suspensory ligament of the lens, a well-defined stage of the operation, there is a school of ophthalmic surgeons in the Punjab who habitually express the lens after the section of the globe, without any preliminary separation. Of these surgeons, Major Smith (22) of Jullundur has published extraordinarily good results.

It will be seen that there is room for much difference of opinion in the management of the operation of extraction of

cataract. The following description must be taken as an average method. It is one which the student will do well to familiarise himself with. If he has acquired the manual skill necessary to perform it neatly and with despatch, he will be able to modify it for himself if occasion arise.

In the description the iridectomy is taken as performed at the same time as the other parts of the operation; many operators habitually combine them as stated here.

Others prefer—rightly, as the authors think—to separate the iridectomy from the extraction by some weeks, unless the patient's condition is such as to make the completion of the operation urgent.

The method of performing a " preliminary " iridectomy is given after the combined method.

Combined Extraction of Cataract

Instruments.—Speculum, fixation forceps, von Graefe's knife, iris forceps, iris scissors, cystitome, two curettes, iris repositor, lens vectis.

The combined operation may be considered in five stages:

1 The incision of the globe.
2 The iridectomy.
3 The incision of the capsule.
4 The delivery of the lens.
5 The toilette of the wound.

First Stage.—The Incision of the Globe.—Though this is considered as one stage, yet there are three distinct parts in it—the puncture, the counter-puncture, and the incision—all of which demand the student's closest attention.

The Puncture.—The surgeon stands behind his patient: this is the position always adopted by English surgeons, as we have already said. For the right eye he will hold the knife in his right hand; for the left, in the left. The grasp is that of holding a pen. With the fixation forceps he seizes the conjunctiva and subjacent capsule close to the margin of the cornea, at the

position indicated in the diagram (fig. 96), and places the point of the knife against the sclerotic, almost at right angles to the globe, at a spot about 1·5 mm. away from the sclero-corneal margin on the outer side of the cornea, about 3 mm. below a horizontal line tangential to the upper circumference. The knife and forceps are thus at the opposite extremities of one diameter of the cornea. This is not the usual practice of English surgeons, but it gives much better command over the globe for the making of the puncture and counter-puncture.

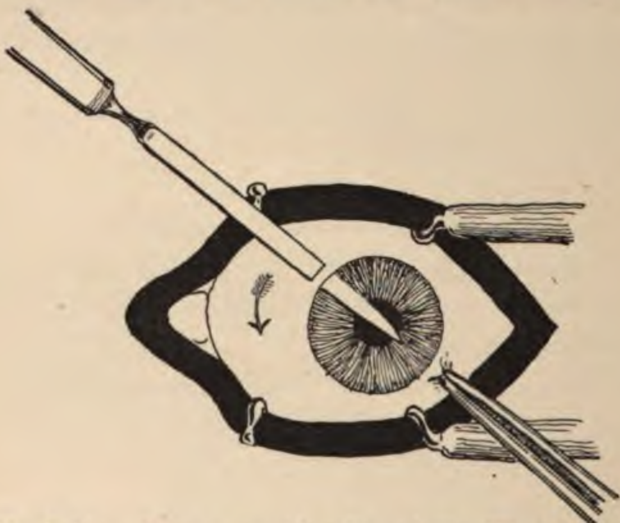

FIG. 96.—Incision of the cornea with a linear knife. When the point has travelled the distance shown, the downward movement of the handle, indicated by the arrow, follows.

As soon as the point is engaged, the surgeon brings the handle back into the plane of the corneal insertion, keeping it still in the line of the diameter between point and forceps, and pushes onwards in this direction, as shown in the diagram, until the point of the knife has passed beyond the opposite edge of the pupil. If the anterior chamber is shallow, and the point approaches the iris too closely, the handle of the knife may be thrown back during the passage of the blade.

The Counter-Puncture.—Then the surgeon brings the knife

into the horizontal line; the point now lies in the iritic angle opposite the puncture; by a slight onward thrust it is driven through the sclerotic, and the counter-puncture is made at a point corresponding to that of entrance.

Until this time no aqueous should have been lost; if the student attempts to pass the knife from the beginning horizontally across the anterior chamber, he will almost always find that the edge of the knife enlarges the puncture and allows the chamber to empty itself. This makes the wounding of the iris likely, and the counter-puncture more difficult to place.

The Incision.—In making the incision it gives better com-

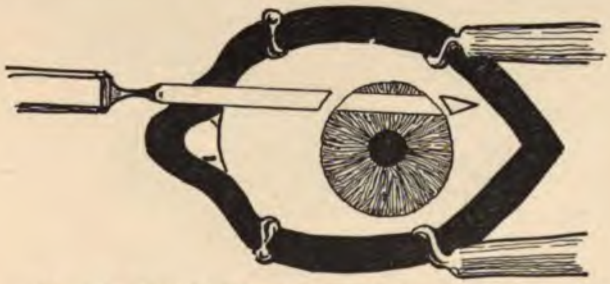

FIG. 97.—Use of the linear knife. The counter-puncture.

mand to take the usual grasp with fixation forceps below the vertical diameter of the cornea.

Now the surgeon cuts upwards through the tissues between the puncture and counter-puncture, gradually approaching the cornea. If the knife be used both for thrust and return, the incision is less regular than if it be used on the successive thrusts only and drawn back without cutting.

The actual cutting of the incision after puncture and counter-puncture have been made, is the subject of various treatment. De Wecker is said to aim at completing the cut in three movements: the first carries the point onwards and upwards, thus making an incision of some length above the counter-puncture; the second movement carries the handle upwards during the partial withdrawal of the knife, and makes the

corresponding incision above the puncture. The blade of the knife now should lie parallel to the position after the two punctures are made, but nearer the upper edge of the cornea. The edge is then turned forwards, and the section completed by a third movement. This necessarily makes the section lie in at least two planes, a condition not favourable to coaptation, according to most surgeons' ideas.

Critchett states that he makes three-fourths of the section with the first upward and onward movement, and finishes as gently and slowly as possible.

While it is advisable to complete the section without undue delay, it seems better to err on the side of caution than to try

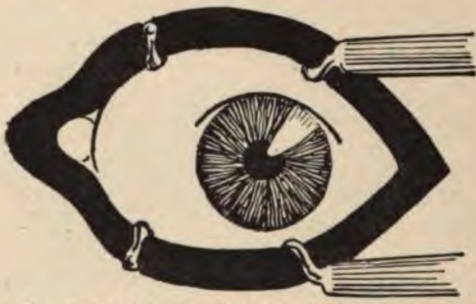

FIG. 98.—The track of the completed incision for cataract extraction.

to acquire a fallacious brilliancy; it is therefore not proposed to lay down here any exact rule for the completion of the section after the knife has made the counter-puncture.

There is no need to hurry the incision; by making it deliberately its position can be more accurately fixed. The central part should coincide with the sclero-corneal junction. If the surgeon keeps his eye fixed on this, he will find the knife finds its own way there; it is often necessary to turn the edge of the knife a little forwards just at the end of the section. The narrow Graefe's knife allows this easily.

As soon as the real incision is begun, and the knife no longer tightly fits the punctures, the aqueous will escape slowly; if it escapes rapidly the iris will fall in front of the knife and will be wounded in the course of the section. The rapid escape of

the aqueous usually means that the surgeon is making pressure with the fixation forceps on the globe instead of merely holding it in place. This pressure of the forceps is a very common fault of students, and is responsible for a good many misfortunes. Not only may it cause prolapse of iris, but even the lens may be prematurely expressed.

The size of the incision has been already dealt with; the surgeon must be prepared to vary it as occasion arises. If the cornea is small, the incision must be relatively larger, since the lens seldom is much diminished in size even in microphthalmic eyes.

In "black cataract" the nucleus is usually large and hard, and the incision must be enlarged accordingly. If, when the extraction of the lens is attempted, the incision be found too small, it may be enlarged with scissors at each end.

A few points must be borne in mind as to the performance of the incision.

It is most important that the puncture should be made straight through the cornea, and that the blade should not be thrust between the layers thereof.

If the handle of the knife be carried too far back before the puncture is complete, the inner mouth of the wound is smaller than normal, and there may be difficulty in delivering the lens.

It is an unpleasant and not very uncommon experience to find the knife has been held with the cutting edge away from the operator during the puncture. (It is always easy to tell the back, by the maker's name on the handle.) If the aqueous have not escaped, it may be possible to withdraw the knife and re-introduce it in the right position. More commonly we must defer the operation until the wound is healed.

Angelucci (23) has recently recommended a small variation in the procedure of cataract extraction, which deserves mention, since it is applicable to many other operations; he discards the speculum and, making the patient look down, takes a firm grasp of the conjunctiva and subjacent superior rectus tendon, about 8 mm. above the cornea. By this hold he prevents

movement of the eye and of the lid, and keeps the latter effectually out of the field of operation.

One of us, without knowing of Angelucci's work, recommended a similar hold when using the keratome to make a corneal incision in the upper part of the eye. There can be no doubt that such a hold gives much better control to the surgeon.

Second Stage.—The Iridectomy.—Unless the patient is very

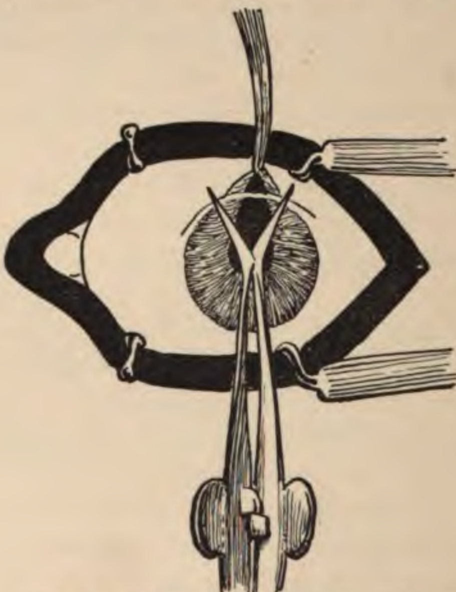

FIG. 99.—Iridectomy in cataract extraction.

nervous, it is not necessary to fix the eye after the incision. The surgeon will need both hands for the later manœuvres. If the patient is restless, an assistant must be asked to "fix." He must be instructed not to press on the eye.

The surgeon, having told the patient to look down, takes the iris forceps in his left hand and introduces them, closed, into the centre of the wound, so far that they reach almost the pupillary margin of the iris. Then he allows them to open slightly; a fold of iris springs up between them, is grasped and drawn out of the globe. This fold is cut off at

one cut with the iris scissors. As the scissors are closed the surgeon presses the blade slightly against the globe; the edges of the coloboma usually spring back into the eye.

The patient sometimes feels the iris section a little, but the pain at the worst is momentary. Often after the use of 10 per cent. cocain, even this section is unattended by discomfort.

Third Stage.—The Incision of the Capsule.—The surgeon takes the cystitome (the best pattern is that known as the Moorfields type) and, introducing it with the back first into the anterior chamber, carries it down nearly to the lower edge of the pupil; then, by rotating it in his fingers through 90° round its own long axis, he brings the point on to the capsule of the lens, and withdraws the instrument towards one angle of the primary incision, cutting the capsule as he goes. No pressure is required for this, nor can the student feel any resistance when he performs the operation on the dead eye. Indeed, if he use sufficient force to give sensation of resistance, he will, in all probability, dislocate the lens backwards into the vitreous.

The blade is then turned, by reversing the rotation, into the first position, and the point is carried a second time to the lower pupillary margin; here it is again turned into contact with the capsule and drawn up to the other angle of the incision; hence, without further withdrawal, it is made to cut across the upper region of the capsule, joining the first incision at the other angle. In this way a triangular flap of capsule is isolated from the remainder.

If the flap be obviously opaque, it may be seized in forceps and drawn away.

Fourth Stage.—The Delivery of the Lens.—Taking one of the curettes, the surgeon makes pressure on the lower margin of the cornea, backwards, towards the centre of the globe. By this the lens is rotated round its transverse diameter, and the upper edge comes forward and engages in the wound.

If the lens does not come forward, it usually means that the

opening in the capsule is not sufficiently free; the capsulotomy must then be repeated. The pressure should be kept up uniformly in the direction stated until the lens is gripped in the wound. It is sometimes of much assistance to make counter-pressure just behind the posterior lip of the wound, to guide the lens into it. When the lens distends the wound, the direction of the pressure may be changed—from directly backwards to backwards and upwards, and the surgeon may follow the lens up as it escapes; as soon as the greatest diameter engages, he must be prepared to cease all pressure, or he may cause a loss of vitreous—an accident which has a serious bearing on the prognosis. As soon as the nucleus is delivered, it is well to remove the speculum, lest a squeezing of the orbicularis should express the vitreous.

Sometimes the vitreous presents before the lens. This is specially the case when it is fluid. There is then fear that the lens will fall back into the vitreous and be the cause of cyclitis. Pressure on the eye will only increase the flow. The vectis, or scoop, must be passed deeply into the vitreous behind the lens and brought forward. The forefinger of the left hand is placed on the lower part of the cornea, so that the lens is felt between it and the vectis, and then is drawn steadily out of the wound. The pressure of the left forefinger steadies the globe and makes the extraction easier.

When the nucleus comes out, the soft cortical matter remains in the eye. This must be removed; it can usually be expelled by means of circular rubbing movements over the lower part of the cornea. The amount of force exercised varies with the skill of the surgeon. The method cannot be explained in words, but can only be acquired by observation and practice.

It must be remembered that the more complete the removal the better the result. Hard fragments of lens lying in the eye can hardly fail to set up inflammation of the iris.

On the other hand, too long manipulation is bad; the surgeon must know where to draw the line.

Occasionally a bead of vitreous shows when the surgeon is

expelling the cortex. All massage should be stopped and the wound closed as soon as possible.

Fifth Stage.—The Toilette of the Wound.—The expression of the lens will usually carry the pillars of the coloboma out of the wound, and these with or without the flap of the lens capsule remain prolapsed. The iris should be replaced with a repositor, and the capsule removed if visibly prolapsed. In every case, however, as a routine, the surgeon must pass the repositor along between the lips of the wound to replace any prolapse of capsule that may be present but invisible. If the surgeon has made a conjunctival flap he will replace it in position before closing the lids.

Preliminary Iridectomy

If the surgeon makes a preliminary iridectomy, he will probably incise the globe with a keratome rather than a Graefe's knife. The wound made by the former coapts itself more regularly, and the healing is quicker.

Instruments.—Speculum, fixation forceps, keratome, iris forceps, iris scissors and repositor.

The operation may be considered in two parts.

First Stage.—The Incision of the Globe.—The surgeon will grasp the conjunctiva about 5 mm. above the vertical diameter of the cornea with the fixation forceps, and, taking the keratome in his right hand, he will place the point on the vertical diameter of the cornea just inside the sclero-corneal junction, so that the blade is at right angles to the point of contact.

As soon as the point is engaged he carries the handle towards himself until the plane of the blade is parallel to the plane of the corneal insertion, and then, pushing the knife steadily in, makes an incision about 8 or 10 mm. long; the point must pass in front of the iris all the way. If the incision be kept entirely corneal, there is usually no difficulty in this. In withdrawing the knife the point must be kept away from the lens capsule, rather towards the cornea.

Second Stage.—The excision of the iris is performed in the manner just described under the heading of combined extraction.

The iris rarely needs reposition.

After preliminary iridectomy, the extraction at the next sitting requires to be performed as in the previous paragraphs, the second stage, that of iridectomy, being, of course, omitted.

Subconjunctival Extraction

A modification of extraction, not without importance, which has received a good deal of attention lately, especially on the Continent, is subconjunctival extraction.

In this procedure, the lens is received first into a pouch of the subconjunctival tissue, prepared by preliminary dissection, and is removed thence afterwards. The object of this is to place the wound in the globe in such a position that infection becomes almost an impossibility. There are several modes in which it is performed; in the most common, the lens is received under a large conjunctival flap, cut during the primary incision, and differing from the usual conjunctival flap only in the fact that it is not separated at its upper limit.

The method which is chosen for description is that of Czermak (24) of Prague, and it has been selected because of its extreme divergence from the usual type.

Czermak's Operation

Instruments.—Speculum, fixation forceps, strabismus scissors, fine scissors bent on the flat, capsule forceps, two spatulæ (one angled), and knife.

Czermak is said to use a large knife, but it would seem from the description that an iridesis knife would answer the purpose.

First Stage.—The surgeon makes a puncture into the anterior chamber at the external end of the horizontal meridian of the cornea.

Since the object is to make the whole incision subconjunctival, the knife should be thrust through the conjunctiva, beyond the limbus, and carried under the conjunctiva to the sclero-corneal

junction, before penetration. The point is passed as far as the centre of the pupil, and here opens the lens capsule. It is then withdrawn.

Second Stage.—The surgeon then makes a long incision through the conjunctiva downwards from the point of puncture for about 15 mm., and, picking up the membrane on the inner side of the incision, he undermines it as far as the tangent of the inner end of the horizontal meridian of the cornea, passing a little beyond this line near the said meridian. This part of the operation must be done with great care, or the flap will be incised.

Third Stage.—An assistant raises the flap of conjunctiva

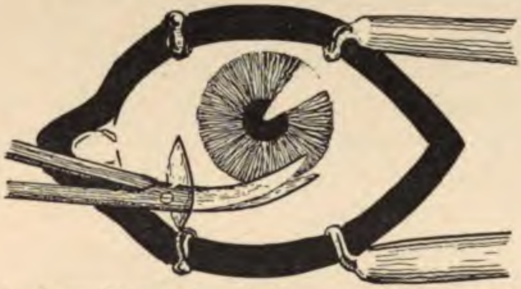

FIG. 100.—Czermak's operation. Subconjunctival incision of the cornea.

with forceps, and the surgeon introduces the posterior blade of the curved, blunt-pointed scissors into the anterior chamber through the primary puncture. The anterior blade lies under the conjunctiva outside the cornea. By repeated cuts he divides the cornea round the margin, subconjunctivally, as far as the internal end of the horizontal diameter, the visible incision lying in the sclerotic.

Fourth Stage.—If the capsule has been efficiently opened during the first stage, the surgeon proceeds at once to the removal of the lens. If the opening be insufficient, he opens the capsule with forceps. Then he makes pressure with one spatula over the upper part of the lens, and holds back the posterior lip of the wound with the other. The lens escapes into the conjunctival pocket, whence it is easily removed.

Fifth Stage.—The conjunctival wound is closed by one or more sutures.

Removal of the Lens in its Capsule

Gradenigo's (25) Operation

Instruments.—Speculum, fixation forceps, linear knife, zonulotome, ring spoon.

First Stage.—The corneal incision must be large; it must lie within the corneal tissue, since hæmorrhage will interfere very seriously with the later delicate manipulations, and must allow the escape of the whole lens without strong pressure. The wound, therefore, must be peripheral, involving a half or even more of the cornea, and thus marking out a very large flap, such as was made in the early days of cataract extraction. Gradenigo recommends that the apex of the flap should not coincide with the vertical diameter of the cornea, but should be placed somewhat obliquely between the insertions of the superior and external recti.

He claims several advantages for this position: that the flap is not easily everted by any movement of the patient, either at the time of operation or afterwards; that the speculum cannot be driven into the wound by any sudden rotation of the globe; that the use of the knife and spoon is facilitated, owing to the relation to the external orbital border; that there is less risk of escape of vitreous; and finally, that a prolapse of iris is specially easy to reduce under these conditions. During the healing, also, the lateral flap is better able to resist displacement.

To encourage speedy healing, Gradenigo covers the surface of the cornea in the region of the flap by a fold of conjunctiva.

Second Stage.—*The Zonulotomy.*—This is the special feature of the operation; the surgeon introduces the special zonulotome a millimetre beyond the lower visible edge of the iris (the pupil being dilated with atropine), so as to be secure from the risk of wounding the lens, and turns it on to the zonule, holding the

instrument very lightly, and encountering no resistance from the fibres. If there should be any appreciable resistance felt, the surgeon must withdraw the zonulotome, and introduce it afresh. With great care he lacerates the inferior part of the zonule, and the lens may be seen to start forward and upwards. Then gradually he divides the rest of the zonule, as far as possible.

Third Stage.—Then by very gentle pressure of the spoon, taking care not to rupture the hyaloid membrane, the surgeon expresses the lens. If the efforts are too powerful, the lens may turn a somersault, and come out of the wound, followed by a rush of vitreous. The lens usually comes out with its anterior surface presenting.

When the lens has thus made exit almost completely from the wound, it favours its removal to make it rotate like a wheel, slowly, while the surgeon divides the remaining adhesions of the zonule.

The escape of the lens allows the lips of the wound to fall into place.

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CHAPTER VIII

AFTER-CATARACT

In a large proportion of cases where cataract has been removed, there appears, early or late, a membranous opacity in the pupil, which interferes more or less with the visual result. This membrane is called after-cataract, or, less properly, secondary cataract. The latter term should be, and generally is, reserved for those cases of true cataract which are secondary to other general or local disease.

The pathology of this veil has been to some extent neglected; it has been assumed that it was made up largely of the lens capsule. Its true nature has been examined by Wagenmann (1) microscopically, and more recently Bates has made experimental investigation of the source from which it is developed.

Wagenmann rests his reports on the examination of two cases; in the first, examined at a date two and a half years after the extraction, there had been a division of the capsule by the cystitome. Vision was finger counting.

The capsule had rolled up behind the iris, which was adherent to it. Between the layers thus brought into contact new lens fibres had developed; the posterior layer had pushed forward into the neighbourhood of the anterior. In the region of the coloboma there was to be seen, on the surface of the posterior capsule, layers of newly-formed capsule substance which seemed to come from the place where the two layers were in apposition.

In the second case there had been avulsion of the capsule by Förster's forceps. In this case the coloboma looked clear, but

vision had gone down from 6/18 to counting fingers. The same appearances were found. It follows from these investigations that the anterior layer of the capsule, on account of or by means of its lining cells, has the power of forming new lens fibres.

The most recent work on the subject of after-cataract is that of Dr W. H. Bates (2).

This is an entirely experimental work, and refers only to the results obtained in rabbits, but it is probable that the pathology is to a large extent similar for man. In this paper Bates promises a separate contribution on the after-cataract in man, but this has not yet appeared.

He has not been able to confirm the view expressed by Schweigger and Fuchs, that the after-cataract is due to thickening of the capsule at some time after operation. He has never found it thickened in any of his experiments. The following is a transcription of his views, given practically in his own words, with the exception that, throughout, the expression "after-cataract" has been substituted for the words "secondary cataract," which Bates uses to name the condition under discussion.

When the anterior chamber is first opened, a clear fluid flows out, which is normal aqueous humour; this does not clot. If, however, a few minutes later the wound be reopened—as, for example, to perform capsulotomy—more fluid escapes, and this clots spontaneously. Such a clot, when stained and examined by the microscope, shows the structure of fibrin. Each time the eye is reopened during the operation, the fluid escaping clots like blood, after standing for a short time.

In eyes enucleated within a few days of the operation, fibrin was found in the pupillary area in every case. If the enucleation were delayed for some weeks, there were present in addition to, but closely associated with, more or less fibrin, scattered connective tissue cells or, later, well-organised connective tissue.

The posterior capsule was always thrown into folds, but in no case was it found opaque or thickened. The capsule was not necessary to the formation of after-cataract, because similar membranes formed in the pupillary area after the posterior

capsule was incised and rolled up behind the iris, and also after the operation when the lens was removed in its capsule. The anterior capsule did not form part of the central pupillary membrane, but was usually found behind the iris. It follows, from this important series of observations, that, at least in the rabbit, the repeated evacuation of the anterior chamber during the operation of extraction of the lens is followed by the formation of fibrin in the anterior chamber and in the pupillary area, in and about which the connective tissue develops which forms the after-cataract. The fibrin seems to act as a nidus for the development of the new connective tissue, the process of organising resembling that of the organisation of a thrombus.

Bates has shown that the repeated evacuation of the anterior chamber alone, without further operation, is able to cause the formation of these membranes.

The nature and mode of formation of the simple form of after-cataract being thus settled, Bates sought to discover a means to avoid its development. He came to the conclusion that the chief desideratum was an operation which did not require frequent opening of the anterior chamber, and which secured speedy healing. Further, by filling the anterior chamber with normal saline after the operation, he avoided the replacement of the normal aqueous by the fibrin-holding fluid.

In the rabbit he finds it a good plan to close the wound with sutures; unfortunately this device seldom succeeds in man.

When healing is not effected without inflammation, the veil in the pupil is thicker and denser, and the iris often adheres closely to the whole surface. Such an after-cataract, following on severe iritis or irido-cyclitis, is usually spoken of as "complicated."

The mode of formation is essentially the same as that of the simple form, but the products of inflammation make up a larger and more resistant layer. At the same time the iris loses a great part of its elasticity and contractility, as a result of the inflammation. The treatment of the two forms will

necessarily vary on account of this difference in their constitution.

The question of dealing with the after-cataracts is one of some difficulty, since there is the most divergent opinion about its advisability and efficacy. On the one hand there are surgeons like Gayet and De Wecker, who say they contemplate the operation with more apprehension than any other; on the other are Knapp and many English surgeons who perform a needling operation in at least 40 per cent. of all extractions. The writers think that the dangers and disadvantages have been over-stated by the French authorities, and are accustomed to advise and perform a needling operation on thin veils of after-cataract, whenever vision falls, apparently from this cause, below 6/12.

There are three chief risks in the procedure: first, that the handling may set up iritis, from disturbance of the iris and ciliary processes; second, that the vitreous be damaged by the efforts to divide the veil and become the seat of hyalitis; and third, that it may prolapse and become adherent to the wound. The first can, to a large extent, be avoided by care, during the operation, to receive the strain on a second needle; the second, by taking care that the needles do not penetrate far into the vitreous, which lies immediately behind the after-cataract, and therefore must be lacerated to some degree. There is a small risk of sepsis, but with ordinary precautions this is minimal.

The third risk—that of adhesion of the vitreous to the wound—is the most insidious danger of them all; it may be guarded against by taking care to retain the aqueous during operation, and after. This is best effected by making the wound very small and valvular. The vitreous can hardly prolapse into a needle puncture so long as the aqueous is not lost. The risk, therefore, is always greater if the wound be sufficiently large necessarily to allow escape of the aqueous humour. When the aqueous escapes, we may sometimes see a string of vitreous follow it out of the wound and hang over the cornea.

This intruding tag prevents immediate healing and offers a

road to the invading micro-organisms. There follows in some cases an infective hyalitis, leading to the formation of bands in the vitreous, by whose contraction the retina may be detached at a later date. In other cases there appear opacities in the vitreous which interfere with vision even more than the after-cataract. Lastly, the invading organisms may be pyogenic and lead to the total loss of the eye from panophthalmitis.

The direct injury to the vitreous seems of small importance when compared with these secondary dangers. In many operations, especially in magnet operations for the removal of splinters, the vitreous must receive extensive laceration from the poles of Hirschberg's magnet, without appearing to resent it at all. Many surgeons have drawn attention to the extraordinary tolerance of the vitreous to aseptic injury under these circumstances.

The modes of treating after-cataract are various, and differ with the nature of the membrane; thin, transparent veils can be dealt with by means of a single or, preferably, two cataract needles. Their edges should be sharp for about one-sixteenth of an inch at least; it is most important that they should cut and not tear the membrane.

Bowman was the first surgeon to recommend the use of two needles; his paper in the xxxvi. vol. of the *Transactions of the Medico-Chirurgical Society* (reprinted among his collected papers) gives fully the reasons for the employment. The bad results which occasionally follow needling are due, for the most part, to irritation of the iris and ciliary body from the tension necessarily put on them when one needle only is used to tear the connective tissue in the pupil.

Bowman therefore advised the surgeon to introduce two needles from the opposite sides of the cornea, and to penetrate the "capsule" at the same spot with both; it is then easy to cut a hole in a thin layer while the opposing needle takes the strain off the ciliary processes. In this manœuvre the membrane is cut rather than torn by the sharp edges of the needles, but,

inasmuch as no drag falls on the ciliary processes, there is little danger if the edges be not very sharp. If, on the other hand, the surgeon try to divide the membrane with a single needle, tension on the attachment of the suspensory ligament is almost unavoidable.

The amount of tension is very slight in uncomplicated cases, when little time has elapsed since the extraction of the lens. Some very expert surgeons, among them Lang, attack all such cases within one month, using a single needle. They claim that at that time the capsule is softer and more elastic, and will roll away from the opening. All definite bands must be left alone.

Lang selects a soft piece of the capsule and cuts it out from the surrounding mass gently, by strokes of the needle to float it out of sight. In this way a clear pupil is left.

Knapp (3), in the *Transactions of the American Ophthalmological Society* for 1898, lays down certain rules for the division of these after-cataracts; chief among them is that the opening must be made by cutting and not by tearing. For this purpose Knapp has devised certain knife-needles having a cutting edge much longer than that of an ordinary cataract needle, and divides the capsule with these.

Kuhnt, who adopts similar methods, has modified the needles by bending them like keratomes; this necessitates two different patterns, cutting to the right and left, for use in the right and left hands.

Stilling and some others use harpoon needles, having two sharp points and two cutting edges.

After each needle has penetrated into the anterior chamber, the recurved point is made to perforate the after-cataract, and the membrane is divided by the two posterior cutting edges. In this way the pull is divided between the two needles.

All these methods are but slight modifications of Bowman's original plan, and if the surgeon sees that the edges of his needle cut for two millimetres from the point, Bowman's operation is as good as any other. It is, of course, important that as little as possible of the needle pass through the hyaloid

membrane; if the needles perforate deeply they will cut up the vitreous to a corresponding extent, and this leads to those accidents which have discredited the operation.

The value of the harpoon needles and of Kuhnt's methods lies in the relatively superficial position of the cutting blades.

But if the risk of vitreous injury is considerable with needles, it is more when a large incision is made in the globe and the after-cataract is avulsed with forceps, as is recommended by certain surgeons. The forceps must penetrate the vitreous as deeply as the needles, and will do more harm; the large incision in the globe favours prolapse and adhesion of the vitreous to the wound. Lastly, the tension on the iris and ciliary body is as great as in the needling operation, and probably greater. It has been suggested that this may be relieved by dividing the points of adhesion by means of a knife before extraction of the after-cataract, but it would be as simple, and no more dangerous, to divide the centre of the membrane.

For the reasons which have been discussed above we are inclined to differ from those very distinguished surgeons who use one needle only; when the membrane is tense and thin, the sharp cutting edge of a proper needle is an admirable instrument for its division. There is, however, some risk of damage to the ciliary processes, which can, we think, be avoided by the use of two needles.

Still more do we dissent from the views of those authorities who would abandon needling operations altogether (including under this term division by Kuhnt's or other knives) and advise avulsion after a large opening of the globe.

The date of these secondary operations is not without real importance from two points of view: the risk of exciting inflammation is greater if a second operation follow, at a short interval, a primary extraction, which has occasioned excessive reaction. When the first operation has been accompanied by little or no congestion of the eye, it is probably not dangerous to undertake the secondary operation within three weeks, as Knapp does, while the after-cataract is still incompletely or-

ganised and the adhesions between it and any part of the uveal tract, if present, are feeble. But to perform any operation, no matter how slight, on an eye which has recently suffered from active iritis or cyclitis, is to court the recurrence of the inflammation in a form and degree which our art may be unable to check. On this account, therefore, delay is advisable in many cases.

Further, the spongy masses which are often seen soon after extraction, filling the pupil, are less easy to deal with than a thin, well-defined membrane, and though they have no firm connection with the iris (and, in part at least because of this), they cannot be removed readily from the central zone of the pupil; they float back when divided, and disconcert repeatedly the surgeon's best endeavours.

When an after-cataract is left untouched for some months, it gradually, in most cases, is converted into a thin, tense, more or less homogeneous elastic membrane, and if a hole be cut in the centre of this, it remains patent, in part because of its inherent elasticity, in part because of the entrance of vitreous into the aperture.

Complicated after-cataracts, in which the iris forms part, are more difficult of treatment. Practically there are two main methods—iridotomy and iridectomy. When the iris retains its muscular tissue but little impaired, backed by a dense inflammatory membrane, a simple incision made with a narrow knife through all will often allow retraction of the iris surrounding the wound and formation of a clear pupil. It is better to put such an incision at right angles to the direction of the muscular fibres, since the retraction will be greater, and consequently there will be less chance of the new pupil becoming blocked.

When the iris is drawn up to the incision in the cornea, and the tissues of the iris are atrophic, it is of little use to make a simple incision, since it would be certainly closed with inflammatory exudation and blood clot. It is then a useful procedure to make an incision in the globe and divide the membrane with narrow scissors, either by a single cut or by two divergent incisions, enclosing a triangular area of the iris with

apex upward; this can be depressed into the vitreous, leaving a gap which is not likely to be filled up by slight inflammatory exudation. In other cases a similar area may be excised.

It is of the greatest importance in all these operations on complicated after-cataract that there should be little or no reaction following. As long an interval as possible must therefore elapse between the two undertakings.

Simple After-Cataract. Operation with a Single Needle

We have already said that some surgeons use one needle only; Cross of Bristol (4) states that he prefers this method wherever possible. He employs a needle with an exceptionally long cutting edge. If the membrane be thin and tense, he perforates it with the needle in the thinnest point near the centre of the pupil, and cuts across the line of apparent tension. He thinks that the operation will succeed in the majority of instances, but if the membrane moves with the needle without division, he at once introduces a second and completes the division after the manner of Bowman.

Lang, as we have said, uses one needle only. He picks out, very gently, a soft area by repeated strokes, and slides it away to leave a clear opening.

Bowman's (5) Operation for Simple After-Cataract

Instruments.—A focus lamp, speculum, fixation forceps, two needles.

As a preliminary step the surgeon examines the condition and nature of the after-cataract, illuminating its surface as well as possible by means of the focus lamp. Those membranes which are thinnest are most readily dealt with; if the surface is irregular and flocculent, indicating a spongy condition of the mass filling the pupil, success is less sure, and it may be well to postpone the operation until the tissue has consolidated, unless there is any urgent reason for immediate operation. The surgeon will notice the position of any specially dense bands,

and will place his needles in such a position as will give him the best chance of dealing with them satisfactorily.

First Stage.—The surgeon takes one of the needles, and, fixing the eye if necessary, makes the needle penetrate the tissues just outside the cornea, opposite one end of the transverse diameter. The blade of the needle is parallel to the plane of the iris. (If any bands demand it, the needle will be entered at one extremity of the meridian at right angles to the bands.) The second needle is made to penetrate the tissues opposite the other end of the transverse meridian, and, like the first, lies with its blade parallel to the plane of the iris. The points are carried on until they reach the middle of the pupillary zone.

Second Stage.—Both needles are then plunged through one opening in the "capsule," no tissue intervening between them. Their cutting edges are then turned towards the tissues to be divided, and their handles are brought towards parallelism with the optical axis. In this movement the membrane in the pupil will be divided by the two needles and a long slit made, which, by the contractility of the membrane, will become ovoid. If the surgeon judges it insufficient, he will pass the needles again to the centre of the pupil, and make a second slit at right angles to the first.

Third Stage.—The needles are then rotated so that they are again in the plane in which they were introduced, and are withdrawn.

Since the shaft fits closely the wound made by the cutting edge in the cornea, there is no loss of aqueous during the whole manipulation; the wound must not be enlarged in withdrawal; unless the needle during exit is in the same position as during entrance, the wound is made L- or T-shaped. This is a most unfortunate proceeding, since it allows the leaking of aqueous for some time and the consequent formation of a new membrane.

Galezowski (6) recommends the use of sickle-shaped needles, and advises the following method. He passes one needle through the sclero-corneal junction, and with it depresses the membrane towards the vitreous, and makes it tense. The second needle

he introduces through the limbus at the opposite end of the same diameter, and turning the cutting edge forward, passes it through the membrane and divides this from behind forwards.

Stilling's (7) Operation

Stilling and some others habitually use "harpoon" needles.

Two such harpoons are used.

The surgeon drives them through the sclero-corneal junction on the flat, and then turns the reversed point, which is also sharp, on to the surface of the membrane to be divided. The points of both perforate the after-cataract near the centre of the pupil, and the curved posterior cutting edges divide the membrane for a greater or less extent. This damages the subjacent vitreous very little, and opens the capsule efficiently. There are some disadvantages, however: first, that only one incision can be made in the after-cataract for each introduction of the harpoons; second, that the withdrawal of the needles is difficult, since the reversed point catches up in the tissues of the cornea, and that, since the shaft of the needle cannot occlude the opening made by the lance-head, the aqueous leaks out during the whole procedure; this is, as we have seen, a very serious disadvantage to any operation.

Kuhnt's Methods (8)

Kuhnt claims for his special knife-needles that they allow greater scope for choice of position. Bowman's needles can be manipulated conveniently only at the extremities of the horizontal meridian, and therefore the chief incision will be horizontal. Kuhnt's knives can be introduced at any part of the circumference; in order that the risk of sepsis may be reduced as much as possible, he passes them for a considerable distance under the conjunctiva before piercing the sclero-cornea.

One knife may be used alone, or under certain circumstances it may be advisable to use two.

When the membrane is thin and tense, well supported by a normal vitreous, Kuhnt recommends the use of one knife.

Method with One Knife

The knife is introduced in the transverse diameter of the eye, about 3 mm. away from the sclero-corneal junction, through the conjunctiva, and travels under this to perforate the sclero-cornea at the outer angle of the anterior chamber. Its point is carried onward until it reaches the vertical diameter of the pupil, the point being above or below the centre and the edge turned towards the centre. The point is then thrust through the after-cataract, and is moved in the segment of a circle, the point of entrance of the knife being the centre. In this way the membrane is divided by an almost vertical incision.

It is impossible for the knife to enter deeply into the vitreous, and this tissue, therefore, cannot be much injured.

Method with Two Knives

When the after-cataract is spongy, Kuhnt recommends that the surgeon should use two knives, one cutting to the right and one to the left. With these he makes two almost parallel incisions, and divides the intervening band by means of the two blades, which are made to cut towards each other, like scissors.

This second method would seem to involve the deeper damage to the vitreous which the first avoids.

Again, if the membrane seem unusually resistant, or if it be desired to avoid all drag on the ciliary processes, the two knives may be entered through a single opening in the after-cataract, and this divided by the two cutting away from the common centre.

Gama Pinto's Operation (9)

In the endeavour to avoid prolapse and adhesions of the vitreous, Gama Pinto recommended the operation which he called posterior discission.

The instrument which he uses for this purpose is a linear knife. Drawing the conjunctiva over a little to the cornea from the outer side, he thrusts the knife through the sclerotic about 6 or 8 mm. from the sclero-corneal junction; he at first directs

the point back towards the centre of the globe, but after it has entered, he changes the direction of the handle (and, therefore, of the point) and brings the latter gradually forwards so as to transfix the after-cataract near the pupil margin of the same side from behind forwards; he then pushes the point onwards across the anterior surface of the membrane to the opposite side of the pupil, and divides the membrane by cutting from before backwards. He then withdraws the knife, making the point follow the same course as during its entrance.

When the hold of the conjunctiva is relaxed, the wound in the sclerotic is covered in, and even if any prolapse of vitreous take place, it is practically impossible for it to be infected.

It would seem, however, that the vitreous would receive more damage from the knife than in many other methods.

Division of the After-Cataract with Scissors

De Wecker (10) is the chief authority for this procedure, which is often most valuable, but is rather to be preferred, as it seems to us, in complicated and thick simple forms of after-cataract.

Instruments.—Speculum, fixation forceps, keratome, or iridesis knife, spring scissors having one sharp-pointed blade.

First Stage.—The surgeon makes a small incision 6 mm. long through the cornea with the keratome.

Second Stage.—Then introducing the scissors closed, with the sharp point back, he allows them to open slightly, and pierces the membrane with the sharp blade near the adjacent edge of the pupil; he then pushes the scissors on until the points reach almost to the opposite side of the pupil; they then enclose between their blades a large piece of the capsule, and on closure this is divided.

The disadvantage of this procedure is that it necessitates a considerable opening of the eye, and interference with the vitreous, which may prolapse.

The disadvantages are rather less when the scissors used are those of Lindo Ferguson (11). They are closed at rest, and have

both edges of each blade sharp. A very small incision is made; the scissors are passed through this closed, and through the after-cataract, which they divide on opening. Even this form of instrument allows the aqueous to escape during its introduction; it has been suggested to make the scissors so sharp that they would make the corneal incision by means of their points, and thus dispense with the keratome; it was thought that in this way the aqueous would be retained until the scissors had finished their work and were withdrawn, but it has not been found practicable to construct an instrument of this nature.

Brudenell Carter has invented a pair of scissors, known by his name, which are more easy to use than those of de Wecker in this operation. They open and shut in the plane of the handle, and not as de Wecker's pattern in a plane at right angles to this. In using the former it is possible and natural to have the handle vertical, but if the latter are used, the handle must lie horizontally, and it is almost necessary to have a right and left pair, having the different blades sharp-pointed for use on the two eyes.

Prouff's Operation

It was to avoid the damage to the vitreous that Prouff proposed the method which is known by his name.

Instruments.—Speculum, fixation forceps, keratome, cystitome.

First Stage.—The surgeon makes with the keratome an incision about 6 or 8 mm. long in the upper part of the sclero-corneal junction.

Second Stage.—Then introducing the cystitome, he divides the after-cataract from below upwards.

This avoids any deep wounding of the vitreous, but the large opening in the globe invites prolapse of this tissue. The operation is rarely performed in this country.

Panas' Operation

Panas (12) recommends the extraction or avulsion of the after-cataract. He points out that for this operation it is

necessary to wait for a considerable number of months before the parts will suffer it without excessive reaction.

Before the operation he examines the membrane very carefully to find the presence or absence of adhesions between the membrane and the iris. If they are strong, he divides them as a preliminary measure by means of a narrow curved knife. If there are none or only very weak adhesions he proceeds to the operation proper.

Instruments.—Speculum, fixation forceps, keratome, special capsule forceps, scissors.

First Stage.—He makes an incision 8 or 10 mm. long, in the upper corneal margin, and withdraws the knife carefully to retain the aqueous as long as possible.

Second Stage.—Taking the special forceps, with the sharp blade backwards, he passes them down into the anterior chamber, perforates the after-cataract with the sharp blade, and passes further down to the lowest part of the chamber. Then he closes the forceps, grasping the tissue between them, and withdraws. The traction is first vertical, and then followed by slight lateral movements. This breaks down small adhesions, and the membrane sometimes comes out whole, but often is held by a sort of pedicle to the upper part of the coloboma, and this pedicle is specially strong when the capsule is adherent to the original wound.

Then the surgeon, having drawn as much as possible out of the eye, cuts it off with scissors and reduces the prolapse.

It is sometimes possible to take hold of the membrane and draw it out of the eye with a Tyrrell's hook instead of forceps. This minimises the disturbance of the vitreous.

Complicated After-Cataract

The commonest form of complicated after-cataract is that found when there has been moderately severe iritis. The pupil is contracted, filled by a dense opaque mass of organised tissue, which extends behind it, and to which it is adherent. The iris has usually undergone some atrophy, but the fibres are still to

some extent contractile. The blocked pupil occupies more or less its normal position.

The surgeon will then generally undertake its division either by means of scissors, as in de Wecker's procedure, recently described, or by means of a knife. The latter usually gives the prettier opening and is attended by less risk of loss of vitreous.

The division by the scissors is preferred by many surgeons, since it is difficult to extend the incision with the knife to the same length without doing great damage to the vitreous. Further, if the iris muscle is more atrophic than had been expected, and the gap refuses to dilate, a second incision can be made with the scissors easily, but can hardly be made with the knife.

The use of the knife, then, should be limited to the less severe cases.

Division with a Knife

We may use either a narrow von Graefe's knife or the slightly curved narrow knife designed by Hartridge.

This should be plunged through the cornea near the margin, and the point carried across the anterior chamber to the opposite side of the proposed pupil. It is usually better to cut across the fibres of the iris. The point then is thrust through the after-cataract, and the membrane divided as far as possible by a single cut. Care must be taken not to enlarge the incision in the cornea, which should be made rather valvular and not direct, so as to retain the aqueous humour during the division of the membrane, and, if possible, after the withdrawal of the knife. To this end it is useful to have a knife with a short blade and a round stem which fits accurately the incision made by the blade.

When the new pupil remains patent, nothing can be more satisfactory than the result of this operation. Unfortunately the wound is often filled immediately with blood clot, which organises and forms a new after-cataract; the instillation of adrenalin before the division will sometimes prevent this mishap.

Division with Scissors

The use of scissors has the advantage of allowing the surgeon to alter the plan of his procedure to some extent, with the discovery of unforeseen conditions.

If the iris tissues be seen to be atrophic, some part of the iris must be removed from the pupil area.

There are several modes of performing this: in one, which may be called a modification of de Wecker's operation, the cornea is incised for about 6 or 8 mm. with a keratome, and into this incision the scissors are passed. The sharp blade pierces the membrane, and two incisions are made united above and diverging as they pass towards the lower part of the iris.

The intervening triangle of iris falls back or is pressed back into the vitreous, leaving a clear pupil.

Kuhnt's (8) Operation

Kuhnt has described a form of operation for this condition which differs a little from that employed by most surgeons.

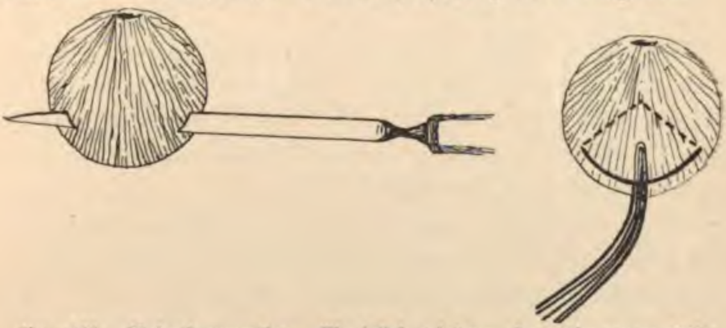

Fig. 101.—Kuhnt's operation. The left-hand figure shows the course of the knife; the right-hand figure, the incisions with scissors.

Instruments.—Speculum, fixation forceps, linear knife, iris forceps, spring scissors.

First Stage.—The surgeon takes the knife and plunges it through the cornea and underlying membrane at a point about midway between the horizontal diameter and the inferior end of the vertical diameter of the cornea, and well inside clear

cornea. As soon as the point has perforated the after-cataract, he sinks the handle into the plane of the corneal limbus, and pushes the blade onward behind the mass, until he judges the point to have reached the position of the counter-puncture; by sinking the handle a little the point is then brought into contact with the posterior surface of the membrane, and driven through this and the cornea, emerging just within the corneal limbus. The incision is now completed, forming a flap of cornea.

Second Stage.—The surgeon then seizes the after-cataract in the iris forceps, and draws it downwards, putting it a little on the stretch. Finally, by two incisions with the scissors, he frees a large piece of the after-cataract, which he draws out of the eye.

Kuhnt has combined this operation with the preparation of a large conjunctival flap which he stitches over the lower half of the cornea, after the main procedure is finished. In this way he protects his wound against the invasion of micro-organisms.

Congenital Dislocation of the Lens

This is the only condition of the lens, apart from cataract, which often requires treatment. It is associated with great disturbance of vision; the lens, being freed from its suspensory ligament, takes the shape of rest, *i.e.* becomes convex on its anterior surface, and gives rise to considerable myopia. When the lens remains in the pupillary area, correction of the defect is easy, by means of a concave lens, though all accommodation is lost with the absence of the tension of the zonule. On the other hand, if the lens be entirely absent from the pupil, the eye becomes practically aphakic, and vision is good with a high convex lens.

So long as all or almost all the pupil is either occupied by the lens or entirely free from it, vision will probably be good, so long as the required correction is worn; but when the lens occupies about half the pupil, and this is the usual case, vision is very imperfect, because of the very irregular refraction, and

one may see the vision improved by either a high concave or high convex glass to about 6/60 without possibility of further improvement.

It is clear that the patient would be much benefited if the lens were either permanently fixed, filling the pupil, or completely removed therefrom. The former has not been attempted as far as we are aware, and the latter plan is not so simple as it seems at first sight.

From the difficulty of removal, many surgeons do not attempt it, but confine their endeavours to making an iridectomy or iridotomy so as to enlarge the aphakic part of the pupil.

Removal of the Transparent Lens in Myopia

The removal of the transparent lens to reduce the refracting power of the eye has been employed in high myopia. The operation is performed as though the lens were opaque.

The aphakic eye has a focal length of about 31 mm., corresponding to a myopia of about 25·0 D. Practically myopes of from 17 to 27 D. are suitable for the operation. There follows in a considerable proportion of cases detachment of the retina, and it is doubtful whether the operation is often justifiable. In no case, we think, should both eyes be operated on.

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CHAPTER IX

THE OPERATIVE TREATMENT OF GLAUCOMA

THE operative history of glaucoma begins in the fourth decade of the last century, when the abnormal hardness of the eye in that disease first attracted the attention of ophthalmic surgeons. As soon as the essential connection between the increase of the intra-ocular tension and the other symptoms of the disease was acknowledged, attempts were made to remedy the morbid state by puncturing the globe and allowing some of the contents to escape; this little operation was performed either behind or in front of the iris.

It was soon found, however, that the relief so gained was temporary only, and until von Graefe (1) showed the good results of iridectomy, the sufferers were condemned to slow or speedy blindness. Since the publication of von Graefe's papers, in 1858, on the subject of iridectomy, this operation has been the chief means of treating glaucoma, and though in recent years removal of the sympathetic ganglia has been acclaimed by some surgeons as an equally efficient procedure, its value has not been universally acknowledged, and few, if any, would recommend that we should proceed immediately to this latter operation before performing an iridectomy.

Von Graefe made his great discovery empirically; the knowledge of the pathology of glaucoma lagged behind the power of treating it. The master's recommendations as to the exact mode of operating are now as true as when he first gave them, but the explanation of their efficiency is even yet to some

extent to seek, though many surgeons have investigated the disease from many points of view. The final clue is still wanting, and till this is found each surgeon's practice will be more or less biassed by divergent theory. Some points, however, are generally accepted.

It is generally agreed that glaucoma is a matter of hydraulic pressure; but whether the excess of intra-ocular tension is due to increased inflow or to diminished outflow is a question upon which ophthalmologists are not yet in accord. It can readily be seen that there would be two chief solutions of the riddle—one would make the disease purely mechanical, following necessarily some anatomical peculiarity of the individual, *e.g.* micro-ophthalmos; the other looks for some nervous disturbance which actively sets up the vascular conditions leading to the rise of pressure.

To make either clear, it is first necessary to discuss the lymph circulation within the eye, and this is a little intricate.

There seems little doubt, from the experiments of Deutschmann (2), that the fluid which circulates in the vitreous is practically all derived from the ciliary body, which acts as a secreting gland, pouring its fluid out through the pars ciliaris retinæ and the hyaloid membrane into the vitreous body. It has been indeed supposed that the choroid had some little part in this process, but it seems theoretically very unlikely that the fluid should have to pass through the delicate nervous elements of the retina on its way to the vitreous humour, and, further, there is no anatomical evidence that any part of the lymph takes this path. Poured out at the ciliary body, the lymph percolates the vitreous humour and then filters through the hyaloid membrane and the suspensory ligament of the lens, into the aqueous chamber, through the pupil to the iritic angle of the anterior chamber, finally making its escape from the globe by passing into the canal of Schlemm through the spaces of Fontana, and thus into the anterior ciliary veins.

There is some little doubt as to the precise nature of the canal of Schlemm; some regard it as a vein, others, again, as a

lymph channel; whichever of these views is correct, there can be no hesitation in asserting that here there is a direct communication between the venous and lymphatic vessels.

No other path of outflow has been demonstrated; some communication between the spaces of the optic nerve sheath and the interior of the eye has been shown to exist, but the flow of lymph is from the nerve to the eye, and never, as it seems, in the reverse direction. It is easy, then, to see that if the anterior path of outflow be obstructed in any way, the inflow remaining the same, the intra-ocular pressure must rise; on the other hand, if the rate of inflow increases, the channels of outflow may become relatively insufficient, and again the patient will suffer a rise of tension.

These, then, are the two chief theories of glaucoma—the first refers all cases to mechanical obstruction; the second demands some nervous mechanism to account for the increase of secretion.

Priestley Smith (3) has made a number of researches into the pathology of glaucoma which are now classic. His experiments showed, as we have already said, first that almost, if not all, the fluid flowing out of the eye escapes through the spaces of Fontana at the iritic angle (which has hence been called the filtration angle). Further experiments showed, that if the pressure in the vitreous was raised above normal, without raising that of the aqueous at the same time, the flow of fluid from the eye was much reduced. When eyes in this state were examined anatomically, there was revealed a change in the position of the lens, the ciliary processes, and the iris. All these structures are pushed forward until the pressure in the vitreous is balanced by the tension of the zonula, and the base of the iris comes into closer relation with the back of the cornea. The spaces of Fontana are thus blocked by the coaptation of the cornea and iris; little fluid or none can escape from the eye; and since the entrance of fluid is not stopped, the intra-ocular tension rises until all entrance of fluid is prevented.

There can be no reasonable doubt that obstruction of the filtration angle by the base of the iris is the real and efficient

mechanism by means of which the enormous tension of acute glaucoma is produced and maintained; but so far there is no indication of the cause of the primary rise in the vitreous, and the hypothesis is therefore incomplete. It is with regard to this primary rise, in fact, that the various theories diverge.

One party sees the cause of the primary rise in mechanical retention, either from a want of space between the lens and the ciliary processes (Priestley Smith) (3), from a change in the condition of the ligament of the lens (Hern) (4), or in an alteration of the chemical constitution of the ocular fluids (Uribe y Troncoso) (5).

Others, headed by de Wecker, see the cause in a hyper-secretion of fluid. De Wecker's theory would make all depend on the condition of the sympathetic nervous system.

All these views are supported by evidence: Priestley Smith has shown that the lens grows throughout life by the addition of fibres to its external surface, just within the capsule, and, therefore, the space between the lens and the ciliary processes decreases as life goes on; the risk of glaucoma increases also with each decade passed; again, he has shown that the lens is the part of the eye which varies least in size, therefore the circumlental space is smaller in the smaller eye; it is precisely in these eyes, micro-ophthalmic or possessing small corneæ, in which glaucoma is seen most frequently. The size of the cornea is a factor of very probable importance in judging of the danger of an attack of glaucoma in any given eye.

Hern's views receive support from the clinical fact that, if an iridectomy have failed, an incision through the ligament of the lens will not infrequently be followed by relief of the high tension.

Troncoso's views are the most recent pronouncement on the subject: he has examined the aqueous humour in cases of glaucoma, and has found an excess of albuminous material therein. It is clear that an albuminous fluid would escape with difficulty from the anterior chamber, and there is little doubt that this is the solution of the rise in tension which

often accompanies iritis, but in these cases the anterior chamber is usually deep and there is no evidence that the spaces of the normal zonule are the seat of the blockage. There is also one other point: Troncoso seems to have taken his fluid from cases of declared glaucoma; it is only to be expected that the fluid in this case would be more albuminous than normal, just as the fluid in the sac of a strangulated hernia contains an excessive quantity of albumen and other proteids.

The nervous theory of glaucoma has also both clinical and experimental evidence in its support: there is, in the first place, no doubt that a nervous shock can bring on an attack of glaucoma in an eye predisposed to the disease; it is possible, however, that this is due directly to the dilatation of the pupil which commonly accompanies mental disturbance. The experimental evidence is more convincing; it has been observed that monkeys and rabbits, in whom the cervical sympathetic has been cut, show drooping of the upper eyelid, contraction of the pupil, and diminution of intra-ocular tension on the side of the division. It seems possible, at least, that in glaucoma the nerve impulses leading to dilatation of the pupil and of the vessels are more active than usual; under these circumstances division of the nerve path will prevent the flow of impulses and stop the disease.

Of chronic glaucoma the pathology is even less clear. There is no doubt that in the majority of cases there is some blocking of the anterior excretory channels—it would, probably, be possible in every case of chronic glaucoma to bring on an acute attack by dilating the pupil, and thus throwing the folded and thickened iris rather nearer to the cornea—but the blocking is not complete. In old-standing cases the base of the iris is often found abnormally adherent to the back of the cornea. This discovery is due to the researches of Knies, and the condition is often called after him, by the name of Knies's agglutination (soudure de Knies). Sometimes there may be no perceptible increase of the intra-ocular tension, though the other signs of glaucoma are all present.

A large number of different procedures have been suggested from time to time for the relief of glaucoma.

They may be divided into several groups.

Operations on the Anterior Half of the Eye.—

Sclerotomy, iridectomy and corneal puncture.
Iridodialysis (de Wecker).
Hancock's operation.
De Vincentiis' operation.
Querenghi's operation.
Heine's operation.
Puncture with the galvano-cautery (in hæmorrhagic glaucoma).
Hern's operation.

Operation on the Posterior Half of the Eye.—

Posterior sclerotomy.

Operations on the Sympathetic System of Nerves.—

Excision of the superior cervical ganglion.
Avulsion of the ciliary ganglion.

The theoretical pathogeny of glaucoma necessarily influences the mind of the ophthalmic surgeon in the choice of operation. If he considers that diminished excretion of fluid is the chief cause of the rise of tension, he will naturally adopt some procedure which will, in his opinion, be most effectual in increasing the possibility of outflow; if, on the contrary, he is convinced that glaucoma is essentially the result of hypersecretion, he will endeavour to reduce the hyperæmia which he supposes to be the base of all the phenomena of the disease. It is from such a theory as to the origin of glaucoma that we have the operations on the sympathetic system.

The form of glaucoma, also, will have great influence on the form of operation adopted; in acute primary glaucoma there would almost certainly be chosen, as a first measure, an iridectomy of the typical kind, preceded immediately, according to the practice of Priestley Smith and some others, by a posterior sclerotomy.

In chronic glaucoma, also, most surgeons would perform, as a

first measure, a classical iridectomy, but a large minority would adopt some other form of treatment. Secondary glaucoma requires treatment, therapeutical or operative, suited to each particular cause; finally, in absolute glaucoma, a number of procedures may be adopted, either to relieve pain or to save a blind but not unsightly eye.

Iridectomy is, however, by general consent the most efficient means at our disposal of reducing or preventing a rise in tension, and must take first place.

Iridectomy

It is somewhat unfortunate that the one term, iridectomy, should be used to cover several procedures essentially different in their aim and method of performance, and only alike in the removal of some part of the iris; but it is hardly possible at this date, even were it desirable, to complicate the nomenclature by introducing special names for the several forms of iridectomy. It is true that the term "iridectomedialysis" has been proposed for the operation which is usually adopted in the treatment of glaucoma, but the length of the name is a sufficient bar to its adoption. We must always have before our mind, however, that the objects of removal of parts of the iris are not always the same; the procedure will vary in form with the effect to be gained. The reader will have seen that the object of iridectomy in the operation of cataract extraction was twofold—to remove that part which was most likely to prolapse, and, at the same time, to facilitate the escape of the lens. Both these aims were gained by excising the pupillary margin; the attached base was not concerned in these affairs, and, indeed, was of some importance if left in the eye, since it helped to retain the capsule after division. When, on the other hand, we are called upon to treat glaucoma, it is the base of the iris which must attract our attention; the base blocks the filtration angle and must be removed. If the surgeon perform an iridectomy such as is most useful in cataract extraction, he will leave the most important part of the iris behind in the eye. Unless the incision of the

globe be very peripheral, and enter the anterior chamber at the filtration angle, the whole depth of the iris cannot be got away. The membrane tears away against the sharp edge of the wound, and a glance at fig. 102 will show that, after an iridectomy, performed as in cataract extraction, about 1·5 mm. of the iris will be left connected with the ciliary body. In glaucoma the pupillary border of the iris is harmless, and if it be feasible to leave it while removing the base, it is as well left.

It is interesting in this connection to call to mind the words in which von Graefe described the form of operation he advised;

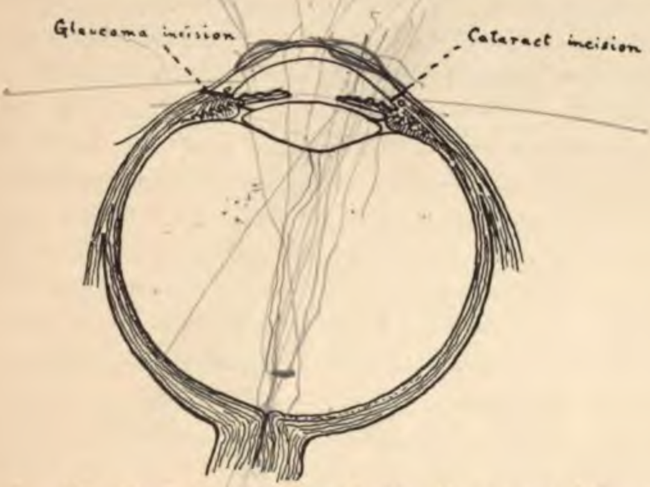

Fig. 102.—Comparison of position of incisions for cataract and glaucoma.

he says (in the translation issued by the New Sydenham Society): "The incisions must be situated as excentrically as possible, so that the external wound may enter the sclerotic about half a line from the cornea, and the internal one just at the junction of the two. It is possible, in this way, to remove the iris as far as its ciliary attachment, and this seems necessary for success; at all events it renders it more certain. . . . The excised piece must be as large as possible. . . . The aqueous humour must be very cautiously evacuated, because a too sudden relaxation of pressure (in the present affection) may

cause extensive hæmorrhage into the internal membranes and cavities of the eye."

These rules of procedure require little or no modification now; it may, perhaps, be objected that we do not remove as large a piece as possible, but it must be remembered that von Graefe operated with a keratome, and hence the possible area of removal was limited.

As to the mechanism by which iridectomy reduces tension, there has been much discussion. There would seem, however, to be little doubt that in acute glaucoma the excision of the iris opens up again the spaces of Fontana, and that the almost constant success which follows in these cases depends on the fact that the filtration angle is not permanently closed by adhesions. The failure of the operation in chronic glaucoma has been used as a foundation for various other theories; it has been supposed that the chief desideratum in the matter is a leaking scar, hence it has been proposed to make an incision into the sclera without removing any part of the iris. There is no evidence that a firmly healed scar, one that does not show the presence of an abnormal fistula, can allow any filtration. If the surgeon knows that he cannot reopen the spaces of Fontana, he must perforce attempt to set up abnormal leakage through the sclerotic, and hence the value of cystoid cicatrices in chronic glaucoma.

It cannot be said that this theory of the action of iridectomy in glaucoma is universally accepted. The reduction of tension has been referred to the reduction of the supposed secreting surface of the iris.

This was, in fact, von Graefe's own view, but the researches of numerous investigators have shown pretty conclusively that the ciliary body is the sole source of the fluids of the eye in the normal state, and, therefore, the theory which rests the increase of tension on the increase of secretion of the iris falls to the ground.

There has recently been published a new theory by Carbone (6), according to which the value of iridectomy depends on the

fact that the section of the iris lays bare openings of veins down which the excess of fluid can, in the glaucomatous eye, escape more easily than through the normal channels. Carbone thinks that this theory meets all facts better than any other; it is, as far as we know, unsupported by evidence, experimental or microscopical.

It seems almost certain that the results of iridectomy in chronic glaucoma are better the earlier the operation is performed. If once atrophic processes have begun in the nerve, there is no certainty that blindness will be averted or even delayed by iridectomy. Nor does an operation, even though performed by the most expert surgeon, always succeed in lowering the tension, while it is practically always followed by a high degree of corneal astigmatism, and a consequent diminution, often considerable, of visual acuity.

It is further stated that, in some cases, a sensible reduction of the field takes place during the time of operation and convalescence.

Seeing, then, that the result of iridectomy in chronic glaucoma is usually, at best, a reduction of visual acuity, with possibility of no permanent relief, many surgeons delay its performance until therapeutic measures are shown unable to check the disease.

The cause of the failure of an iridectomy to reduce tension in these cases seems to be, as has been said above, an adherence of the base of the iris to the posterior surface of the cornea.

Under such circumstances, even with the most peripheral section, the base of the iris is often left behind, and the spaces of Fontana therefore remain blocked when the iris is torn away. Unless a permanent fistula is made there can be no lasting benefit. As soon as the wound heals, the escape of fluid will be stopped.

If the scleral wound be held open by a small piece of iris, the conjunctiva heals over it, but there is permanent leakage; the fluid elevates the overlying conjunctiva, making what has been called a cystoid cicatrix.

Such wounds are, however, by no means free from risk. The drag on the iris and ciliary body may set up inflammation, and, further, the conjunctiva alone is but an imperfect protection against the invasion of micro-organisms. A considerable number of cases have been recorded in which panophthalmitis and complete destruction of the eye followed, at some distance of time, and without any further wound, healing with a cystoid cicatrix, and in a few instances sympathetic ophthalmia has led to the destruction of the other eye.

Taking all things into consideration, it seems to us that the best treatment in chronic glaucoma is to operate early if both eyes are but slightly affected, and thus give the best chance of a complete cure.

When, on the other hand, one eye is already blinded, and the vision of the other is much reduced by the disease, it is very questionable whether the possible good from immediate operation is not more than counterbalanced by the risk, and in such a case the authors are inclined to delay operation by all possible means.

Eserin and massage will often preserve the eye *in statu quo* for twelve months or more. If by progressive failure of vision, either in acuity or field, these means are shown useless, an iridectomy must be done.

In acute glaucoma the tension of the eye prevents absorption of cocain, and, therefore, a general anæsthetic is necessary.

The after-vomiting is sometimes a troublesome or even dangerous complication, and it may be inadvisable for many reasons to give either chloroform or ether.

A posterior sclerotomy, as described hereafter, will often allow us to do the major operation twelve or twenty-four hours later under cocain, and in any case will make the iridectomy easier. One of us uses it in all cases.

If, however, a general anæsthetic is given, the eye is usually found rotated strongly upwards, and two pairs of fixation forceps will be found useful in rotating it downwards.

THE OPERATION OF IRIDECTOMY FOR GLAUCOMA

Instruments.—Speculum, fixation forceps (two pairs), keratome or von Graefe's linear knife, iris forceps, iris scissors and repositor.

The operation of iridectomy must be considered in two parts. The first stage, the incision of the globe, will vary with the knife selected. The second stage, the excision of the iris, is the same under all circumstances.

First Stage (A).—*The Incision with von Graefe's Knife.*—It can easily be seen on reference to any anatomical diagram that the sclerotic overlaps the cornea considerably at its anterior edge. It follows that to reach the base of the iris an incision must be entirely in the sclera. The incision for cataract extraction is, therefore, absolutely unsuitable for glaucoma iridectomy; when we draw the iris out, it will tear off against the sharp posterior edge of the wound, and will leave its base behind, to block the filtration angle as effectively as before.

We must, therefore, make the incision entirely scleral.

When the surgeon prefers to make the incision with a linear knife, he grasps the conjunctiva with the fixation forceps near the inner end of the transverse diameter, but rather below this. Such a hold gives greater command for puncture and counter-puncture than the usual one below the vertical diameter of the cornea, and is of great assistance if the sclerotic is tough.

He then places the point of his knife at right angles to the sclera, about 1·5 mm. from the sclero-corneal junction, about 2·5 to 3·0 mm. above the transverse diameter. As soon as the point has entered the anterior chamber, the handle is depressed into the plane of the corneal limbus, and the knife is pushed on parallel with the transverse diameter of the cornea. The surgeon must watch the knife carefully to see that he does not cut onwards at this stage, or catch the iris with the point of the knife. During the passage across the anterior chamber the plane of the knife, though approaching that of the corneal insertion, may have to vary slightly; at the end of the passage

the handle is raised slightly and the point carried well back into the iritic angle to make the counter-puncture.

The method differs if the chamber is very shallow; when

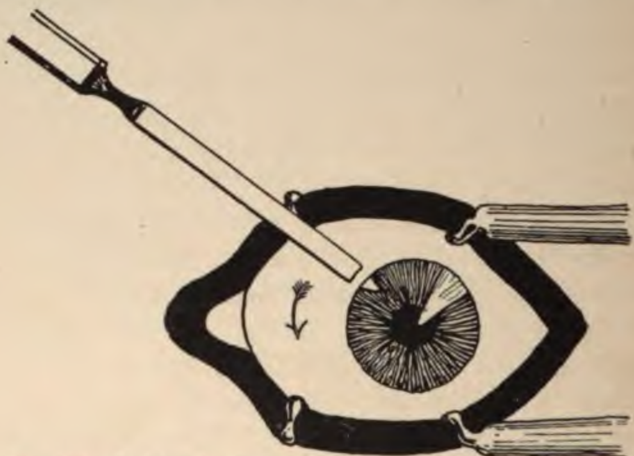

FIG. 103.—Incision for glaucoma with linear knife. The downward movement follows bare penetration.

the lens and iris are pushed much forward, the periphery of the chamber is a little deeper than the central zone; hence the surgeon will carry the point of his knife round the edge

FIG. 104.—Incision for glaucoma. The dotted line shows the track of the point.

of the anterior chamber, making it describe a segment of a circle between the puncture and counter-puncture. The point follows the apparent corneo-scleral junction. In such a passage the back of the knife plays against the iris and tends

to push it away from the point and cutting edge. Great care is needed to avoid enlarging the puncture before the point has travelled sufficiently far.

Until the knife has travelled across the anterior chamber and has made the counter-puncture, no aqueous should have escaped. As soon as the wound is enlarged, this escape can be no longer prevented.

To complete the incision, especially when the sclerotic is tough, it will often be found an advantage to grasp the conjunctiva and Tenon's fascia below the cornea instead of on the inner side; this necessitates loosing the grip of the fixation forceps and taking a fresh hold, but this seems little disadvantage. The surgeon then cuts rapidly upwards, keeping

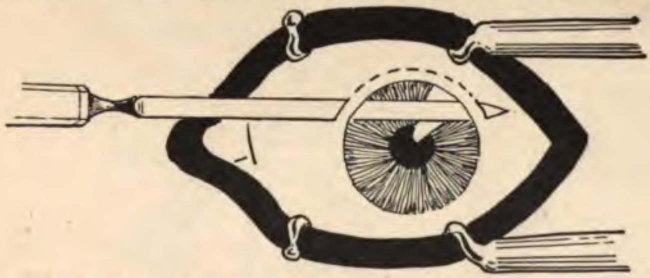

FIG. 105.—Incision with a linear knife; puncture and counter-puncture made. The dotted line shows the course of the incision.

the wound entirely in the sclerotic, about 1 mm. from clear cornea, and, therefore, making a conjunctival flap. This must be turned forwards over the cornea, during the excision of the iris, and replaced in its original position before the lids are closed.

The chief advantage of the linear knife over the keratome is the ease with which its direction can be modified, and the position of the wound changed, even after the incision has been begun.

This is so very important that few surgeons use the keratome for the incision, though it was always used by von Graefe.

First Stage (B).—*Incision with a Keratome.*—When the keratome is chosen, the surgeon grasps the conjunctiva and

Tenon's capsule with the fixation forceps about 5 mm. above the cornea, and places the point of the keratome about 1·5 mm. outside the sclero-corneal junction in the line of the vertical axis of the cornea. The blade of the knife is at right angles to the plane of the sclerotic at this point, and the handle thrown forwards. The point enters until the surgeon judges the membrane just perforated, and then the handle is carried back until the plane of the blade is parallel with the plane of the upper part of the anterior chamber.

The surgeon then pushes the knife steadily on, watching the point to see that it passes in front of the iris, until an

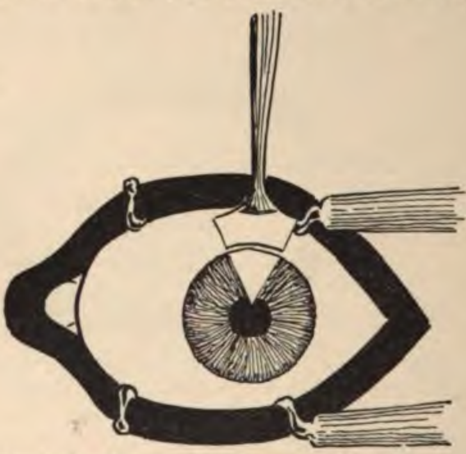

FIG. 106.—Incision for glaucoma with a keratome.

incision some 10 mm. long is made. If the knife seems to approach the iris too closely, the handle must be pressed back; this movement will throw the point forward.

Every care must be taken to prevent the point of the knife being entangled in the iris; any perforation of this membrane means almost certain wounding of the lens capsule. On the other hand, if the surgeon is driven to withdraw his knife to disentangle the point, the aqueous will escape, and the iris can hardly be passed without wounding.

While the incision is being made no aqueous should escape, the knife filling the wound accurately, and, of course, lying

altogether in front of the iris. During withdrawal the chamber necessarily empties itself; the lens is driven forward by the pressure in the vitreous, against the blade, and there is real risk that the lens capsule may be wounded, with the consequent formation of a traumatic cataract, unless the surgeon remembers this.

In withdrawing the knife, therefore, he will carry the handle backward and make the point slide along the posterior surface of the cornea. The grasp of the forceps here advised above the cornea is not that most usually adopted; it is the grasp universally adopted when an iridesis knife is used, and seems to us to have several advantages. In the first place, if the knife and forceps are at the opposite ends of the same diameter, the two instruments will tend to compress the globe between themselves, and this pressure, if the globe be tough or the knife blunt, will suffice to drive the aqueous out of the eye and make the anterior chamber more shallow. If, on the contrary, the knife and forceps are close together, the forceps being behind the knife, such compression is impossible.

Further, with the present hold, it is easy for the surgeon, if he desires, to enlarge his wound during withdrawal of the knife, by cutting away from the forceps, which offer sufficient resistance. This is a difficult manœuvre with the usual hold.

The advantages of the keratome are as follows:—The incision is made with a single thrust and the edges of the wound come better into apposition. The knife fills the wound until the section is completed, and, therefore, the aqueous is retained until the last moment and the iris escapes untimely damage by the edge. Further, there is no necessity for ambidexterity; the right hand can always hold the knife, whether the left or right eye be the subject of operation.

Its disadvantages are the difficulty of sharpening—which makes a good keratome a rarity in hospital practice—the difficulty of avoiding the iris in a shallow chamber, and the danger of wounding the lens when the point is in the pupillary area. Further, the direction of the knife cannot be altered,

after the incision has gone beyond a mere puncture, without undue force.

The difficulty of the incision increases as the depth of the anterior chamber diminishes, since the knife, which is practically a plane triangle, must be introduced into a space whose form is a thin meniscus of considerable curvature.

When the chamber is very shallow, the handle of the knife must be thrown back while the incision is being made, to keep the point away from the iris; this brings the lateral parts of the incision forward, until the extremities lie at or inside the sclero-corneal junction; of all the parts of the incision, it is most important that the extremities lie well behind the cornea.

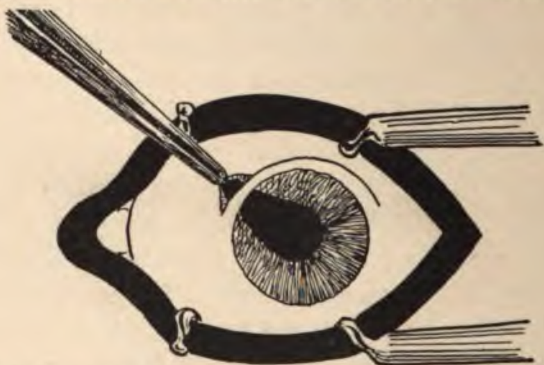

FIG. 107.—Iridectomy for glaucoma; the iris drawn out of one edge of the wound.

The preliminary sclerotomy does away largely with these difficulties by increasing the depth of the anterior chamber.

Second Stage.—The Excision of the Iris.—If the patient is under an anæsthetic it will probably be necessary to ask an assistant to rotate the globe downwards with fixation forceps so as to bring the wound into an accessible position.

Then the surgeon introduces the iris forceps, held closed in his left hand, into one angle of the wound, and, opening them, grasps a small fold of iris near the pupillary margin, which he draws out of the eye. With the scissors a radial incision is made in the iris, extending from the pupil as far towards the base as possible on the outer side of the forceps, so that the

part grasped and bruised in them may be excised. Then the iris is torn away from its attachment along the length of the wound, and cut off at the opposite angle.

The elasticity of the iris will usually draw the angles clear of the wound; if they do not clear themselves, we think they should be replaced; others advise non-interference, for the reason that a very small prolapse hardly interferes with the healing, and in chronic glaucoma more especially, as we have seen, a cystoid cicatrix seems advantageous.

Some very skilful surgeons modify this excision of the iris in the following way:—When they grasp the iris, they inten-

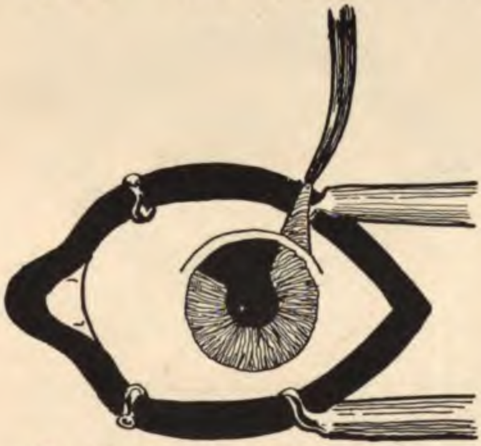

FIG. 108.—The iris torn away from its base.

tionally produce a small iridodialysis, by drawing the iris towards the other side of the wound. They then divide the iris, and, if necessary, on account of the insufficiency of the dialysis, they tear it from its root in the usual way; but before cutting it off they produce a dialysis at the other side also. The size of the part excised is not so large as usual, but by the two dialyses the angle is freed to an unusual extent.

An iridectomy performed in this way is the best safeguard at present known against the recurrence of increased tension, and, as we have already said, it should be undertaken as soon as possible after the recognition of the nature of the disease,

except in very advanced forms, when from the atrophy of the iris and optic nerve the difficulty of the operation is much greater and the chance of ultimate success much less. The excision of the iris cannot be done too early in the chronic cases, and in eyes in which, though apparently normal, we have reason to expect the onset of glaucoma, an iridectomy may fairly be advised without the actual presence of any definite symptom. This, which may well be called protective iridectomy, should be undertaken, for example, when one eye has been lost from fulminating glaucoma and the other shows a shallow chamber. The risk of the operation in a healthy eye is practically nil, and by a well-placed iridectomy the eye will

FIG. 109.—Completed iridectomy with bilateral dialysis.

be saved the risk of an operation during an acute attack, which will most probably come on, if no iridectomy be performed.

There is, indeed, one risk, which, while small, is very important. Occasionally severe hæmorrhage follows immediately after operation, and the flow of blood drives the vitreous and lens out of the eye. A hæmorrhage of this kind must take place in the vitreous chamber, and comes from some large vessel which has given way on the reduction of the intra-ocular tension, because its walls are no longer able to support the pressure of the blood. Such an accident, therefore, is more likely to occur in patients having abnormally high blood-pressure or diseased vessel-walls.

Whenever either of these conditions can be diagnosed, the utmost care will be needed to avoid an accident.

The blood-pressure must be lowered by previous medicinal treatment before any operation is undertaken, and at the time of operation the intra-ocular tension must be lowered gradually so far as is possible. Unless these precautions are observed, the surgeon may have to regret his advice, since these preventive iridectomies are performed on patients whose sight is yet good, before, indeed, the patient would naturally become aware of any ocular defect.

Even more serious is the responsibility when one eye has been already lost from any cause and the fellow is threatened with glaucoma; here, naturally, all precautions must be redoubled.

When the anterior chamber is very shallow, it may be impossible to open it without wounding the iris if the ordinary plan of incision is adopted ; for such emergencies a method has been devised by Gayet (7) and modified by Dufour (8).

The chief point is that the incision is made from without, inwards; a knife with a convex blade is applied to the cornea or sclerotic at the selected point, and in a plane at right angles to the surface. As soon as the slightest escape of aqueous shows that the anterior chamber is entered, the knife is laid aside and the incision is completed by means of scissors (Gayet) or bent knives (Dufour). The corneal incision being thus ended, the iridectomy can be made in the usual way. There are one or two inconvenient points about Dufour's operation; in the first place the iris may be wounded at the time of penetration of the cornea or sclerotic ; this is a real danger, but not a serious one. A more troublesome complication is hæmorrhage, either from the iris or the sclerotic.

Czermak (9) describes a similar method for employment in all cases of glaucoma. It differs from Gayet's plan only in the fact that Czermak makes a preliminary dissection of the conjunctiva from the region of the proposed incision before using the scalpel to cut the sclerotic.

Gayet and Dufour's Operation

In this method, as we have already said, the incision is made through the cornea from without inwards.

Instruments.—Monoyer's fixation forceps, which grasp the conjunctiva at two points (unless these are used, the eye cannot be held sufficiently steady to allow the incision), speculum, knife with convex edge, two knives like iridesis needles, iris forceps, scissors and repositor.

First Stage.—The surgeon grasps the conjunctiva with the special fixation forceps, applying one point above and the other below the cornea, and then places the knife at a point at the end of the transverse diameter, keeping the plane of the blade at right angles to the surface (the incision is made most easily at the inner or outer side of the cornea; if it be desired to make it either at the upper or lower border, the fixation forceps must be applied to the extremities of the transverse meridian). By sawing movements the cornea is gradually cut through; care must be taken to keep the knife constantly in contact with the tissues, otherwise the incision will be jagged.

Second Stage.—The surgeon now lays aside the first knife, and taking the iridesis knives, introduces their points into the anterior chamber through the incision, and enlarges the wound as far as he thinks proper. (Gayet's original recommendation to enlarge with scissors seems less likely to give a smooth wound than that in the text.)

Third Stage.—The iridectomy is then performed as usual.

Sclerotomy

De Wecker (10) has always been of opinion that the efficiency of the operation of iridectomy lies in the large corneal section, and that the excision of the iris has nothing to do with the relief of tension. This opinion he has consistently upheld, since, following Stellwag, he adopted the operation of sclerotomy at the Heidelberg Congress of 1863. Other surgeons, *e.g.* Quaglino, have from time to time expressed similar views, but there has

never been a general acceptance by ophthalmologists, who regard sclerotomy rather as a possible adjuvant, if iridectomy has failed, than as a primary procedure of first rank.

There are two distinct ways of performing sclerotomy—either to make a large incision into the globe outside the clear cornea with a keratome or von Graefe's knife, or to perform a sclerotomy "à pont," the incision by the Graefe's knife being left incomplete. The great risk of the simple sclerotomy is a large prolapse of the iris; this is greater with the use of a von Graefe's knife than with a keratome.

Quaglino (11), who used the keratome, says that it is easy to prevent the prolapse of the iris if we withdraw the knife slowly, pressing gently on the iris during the withdrawal.

Bader (12), who very early adopted the operation of sclerotomy, gave the following directions for the incision:—

"The knife is thrust through conjunctiva and sclerotic into the aqueous chamber as near as possible to and in front of the insertion of the iris, is carried across the aqueous chamber without sparing the iris should it interfere with the course of the knife, and is again thrust through the sclerotic and conjunctiva (as near as possible to and in front of the insertion of the iris). Having thus made the puncture and counter-puncture, the incision through the sclerotic is completed (in the same manner as is usual when making a corneal flap for the extraction of cataract) slowly, especially when near completion, so that the knife escapes from the sclerotic beneath the conjunctiva without any jerk. Having reached the conjunctiva, the blade is placed flat upon the outer surface of the sclerotic, the cutting edge directed backwards, and while slowly withdrawing the knife from beneath the conjunctiva, some of the latter is separated from the sclerotic. As large a bridge of conjunctiva as possible should be left, stretching across the sclerotic incision. It is beneath this conjunctiva that the aqueous humour escapes; the iris sometimes protrudes, etc. The extent of the sclerotic to be divided is equal to nearly a third of the circumference of the cornea. It gives least trouble when made along the upper margin of the cornea."

A soundly healed cicatrix is little, if at all, more permeable than the normal sclerotic tissue, and it has been shown that this is, to all intents and purposes, absolutely impermeable; hence, when there is reason to think that an iridectomy will not succeed in re-establishing filtration, because of iritic adhesion or other cause, and when, therefore, the surgeon knows that success depends on making a scar which will allow filtration, he should attempt to secure a cystoid cicatrix. To this end he will allow the edges of the coloboma to remain between the lips of the wound; many surgeons habitually attempt, in this way, to make a permanent leakage from the anterior chamber.

The conjunctiva heals readily over these small prolapses, which give, as a general rule, no trouble during the healing.

The elder Critchett, in the first volume of the *Moorfields Reports*, describes an operation of sclerotomy with the production of a prolapse of the iris.

A very similar proceeding has been recently recommended by Major Herbert (13), of the Indian Medical Service, who reported to the Ophthalmological Society the results of a large number of cases in which he combined a large sclerotomy with the production of a large prolapse of iris. His intention was to prevent the close union of the wound, and thus to ensure free leaking. His sclerotomy wound was large and complete, though covered by a fold of conjunctiva.

At first he made no iridectomy, but the tissues of the iris resisted the passage of the fluids for a long time, and finally he made a practice of excising a small piece of iris, so that the fistula was established at once. So long as the portion of the iris which is prolapsed is covered with conjunctiva, there is, according to Herbert, little risk of infection of the wound, and though the risk of sympathetic inflammation is real, it also is small and may be disregarded. He claims that this method is better able to provide a permeable scar than any other, and gives statistics of the results which he obtained in India that seem to show the operation worthy of more respect than would naturally be supposed.

In a second series of cases he tried to secure the same form of scar in a different way, by tucking a fold of conjunctiva between the lips of the scleral wound. He made a large conjunctival flap above the section and pushed a fold of it down into the open wound. The extremity of the flap lay on the sclerotic above the section. As soon as the anterior chamber reformed, the fold of the conjunctiva was distended by the aqueous and formed a bulging prominence above the wound. This did not heal firmly, and there remained a subconjunctival fistula, allowing the free escape of the aqueous. Not all the cases were so successful; in some the fold of conjunctiva did not remain long enough depressed to prevent healing; in one the fistulous track was too big. Later, Herbert secured the fold of conjunctiva down into the wound by means of a special suture; he tied the two threads of a suture into a knot, and passed it through the middle of the conjunctival flap; then, with great care, he passed the needle into the anterior chamber and brought the suture out through the uppermost edge of the cornea, and the two ends of the thread tied on the surface. It was removed after twenty-four hours.

A somewhat similar method for keeping the fistulous track open was devised some long time ago, we think by Walker, whose hyposcleral cyclotomy will receive mention below. He made a small incision through the sclero-corneal tissue into the anterior chamber; then he dissected up a narrow flap of conjunctiva, having the base as near the incision as possible, and finally pushed the strip of conjunctiva through the opening into the anterior chamber. The wound leaked permanently.

There are several important objections against these procedures, serious enough to prevent their common adoption. In the first place, the presence of a large prolapse is an immediate source of danger, the wound is more likely to become infected and cause total loss of the eye. In the second place, these large prolapses are constantly the cause of severe iritis and cyclitis, which frequently is followed by sympathetic inflammation. Even if the wound heals without irritation, there is

considerable risk of late infection, months or even years after. Finally, a much less serious disadvantage, the bulging occasions much astigmatism.

The surgeons who use the narrow knife, usually, as de Wecker, do not complete their section, but, having made puncture and counter-puncture, cut on until there is left a bridge of tissue 4 or 5 mm. broad, between the two parts of the incision; the knife is then withdrawn. This bridge of tissue does not contain the whole thickness of the sclerotic; the knife necessarily divides the deeper fibres across the centre of the bridge, and only the superficial layers are left: they, however, are an efficient guard against prolapse in the centre of the wound.

Reduced Sclerotomy

Rochon Duvigneaud's (14) Operation

Still more effectually to prevent prolapse, Rochon Duvigneaud described an operation which he called "reduced sclerotomy." Having made puncture and counter-puncture near the horizontal meridian, in sclerotic about 1·5 mm. beyond the corneal margin, he withdraws the point of the knife into the anterior chamber and makes it describe a semicircle against the tissues at the iritic angle, without enlarging his puncture at all.

De Vincentiis (15), under the name of incision of the sclero-corneal angle, has described an almost exactly similar operation, which he performs with a needle.

If the reduction of intra-ocular tension depends on the leakage through the scleral wound, the larger the wound the lower should be the tension. Argyll Robertson proposed (16) to remove a round piece of the sclerotic by means of a special trephine, and thus leave a large area over which transudation could easily take place. In the communication to which we are referring, four cases are given; in all some benefit was the result of the trephining. In one case iridectomy was done on the other eye; the results were similar for the two.

The operation does not seem to have any great support, and Argyll Robertson did not long continue its employment.

Lagrange (17), at the last Congress of the French Ophthalmological Society, read a paper on a new operative treatment for glaucoma, by which he hopes to combine the good results of iridectomy with those of a permeable cicatrix. His method of making the incision and his treatment of the sclerotic both differ from those usually adopted.

Lagrange's Operation

Instruments. — Speculum, fixation forceps, linear knife, fully curved scissors, iris forceps, iris sissors, repositor.

First Stage.—The surgeon makes a peripheral section of the sclero-cornea with the knife, and, as soon as the edge reaches the upper limit of the anterior chamber, he turns it backwards, and cuts out through the sclerotic obliquely. This makes a small chamfer on the posterior lip of the wound and leaves a piece of the sclerotic adhering to the cornea. Then he turns the edge fully back and makes a large flap of conjunctiva, before this membrane is divided.

Second Stage.—He then turns the flap of conjunctiva over the cornea, and removes the fragment of sclerotic that was left attached to the cornea by means of scissors.

Third Stage.—An iridectomy is then performed in the usual way. The removal of the fragment of sclera leaves a large area through which the ocular fluids can transude. The operation is too new to allow us to judge whether the results are all that the operator claims.

Lately Haberkanp has published (18) a proposal to treat certain cases of glaucoma, in which an iridectomy is impracticable or inadvisable, by a puncture of the anterior chamber by the galvano-cautery. The wound thus made remains open for some days, and the tension consequently remains below normal for the same time. The proposal is of limited application, but is of real value within definite limits.

Some operators have combined the sclerotomy with an iridodialysis. Thus Knies (19) expressed his opinion that the value of iridectomy was chiefly in the fact that removal prevented prolapse and adhesion. He therefore, in dealing with glaucoma, cuts through the attached base of the iris with his knife at the time of the section of the globe, making an operative partial iridodialysis. He calls the method "irido-sclerotomy."

On the other hand, de Wecker (20) at one time made use of combined sclerotomy after the following method:—

De Wecker's Combined Sclerotomy

Instruments.—Speculum, keratome, fixation forceps, iris forceps with rounded ends.

First Stage.—The surgeon makes an incision 6 mm. long, a good millimetre outside the corneal margin.

Second Stage.—He then introduces the iris forceps, and seizing a fold of the iris, pushes the forceps on towards the centre of the anterior chamber, until he has torn the iris away from its attachment for an extent of about 6 mm. He then relaxes his hold on the forceps, allowing the iris to escape from their grasp, and withdraws them open.

This operation is followed in some cases by hæmorrhage. In effect, if successful, it is practically the same as an ideal iridectomy.

This procedure of de Wecker is one most suitable for the relief of tension, if the theory of obstruction is correct. It is not infrequently adopted in principle by surgeons in the performance of the classical iridectomy, in that they make, intentionally, an iridodialysis beyond the extent of the excision of the iris. This is practically the same as de Wecker's method, with the excision of the central fold of the iris, that part which has been grasped and bruised in the forceps.

No other method seems equally efficient, theoretically at least, in separating the iris from the cornea, when once adhesions have been formed. Therefore it would seem the method

of choice in chronic glaucoma. When the iris is very atrophic, the tissues will probably not stand the strain, and the separation will not be complete, but if the iris be grasped well towards the root, the chance of separation is fair, even in atrophy.

Kenneth Scott (21) has recently advocated the excision of the attached border of the iris only. He thinks that this method is not only as efficient as the more usual form in removing the blockage from the iritic angle, but also that by preserving the sphincter iridis the pupil is kept smaller after the healing of the wound.

It is clear that such an operation calls for more than ordinary care, and for its success demands that the iris tissues be approximately normal; if, as is often the case in chronic glaucoma, the iris is thin and atrophic, unable to bear the smallest strain without tearing, the prospect of success is small. On the other hand, in acute glaucoma the hæmorrhage is often sufficient in amount from the congestion of the parts to obscure the field of operation and hinder the delicate handiwork of the surgeon.

The account of the method given by Kenneth Scott is very scanty; it would appear to us very difficult to effect an excision such as he describes unless an iridodialysis be made after de Wecker's method, and the excision of the tissues be performed after this.

Hancock's Operation (22)

Hancock supposed that in glaucoma the ciliary muscle was thrown into constant spasm, or became atrophied; the loss of elasticity made the circulation through the vessels of the choroid less free, and thus brought about the increase of tension. He thought that by dividing the ciliary muscle he would remove the obstacle to the vascular flow.

With this object he thrust a Beer's knife through the sclero-corneal junction, at the outer and lower margin of the cornea, directing the point obliquely backwards and downwards until the fibres of the sclerotic were divided for more than an eighth of an inch. The original instructions lay down that the incision must not invade the cornea.

Although Hancock claimed to have good results, he found few imitators. Among these were Walker (23), of Liverpool, who modified the incision in the following way.

Hyposcleral Cyclotomy

Walker's Operation

He passed a very narrow knife through the clear cornea, close to the margin, with the edge turned away from the centre. He thrust it onward, through the base of the iris, taking care not to injure the lens. Finally he withdrew it, cutting down to the sclerotic as it came out. In this incision he describes a sensation of dividing a mass of gristle.

Querenghi (24), of Milan, has made a similar suggestion, in the shape of an operation which he calls sclero-choriotomy. Arguing on the supposition that glaucoma depends on the want of communication between the peri-choroidal spaces and the aqueous chamber, he endeavours to place an incision in such wise that it will divide the ciliary muscle at its attachment to the sclera, and thus will form a passage between the two spaces. His method is as follows:—

Querenghi's Operation

With a narrow Graefe's knife he makes a puncture through the sclerotic about 2 mm. outside the cornea; as soon as the point has entered the posterior chamber he lowers the handle and pushes the blade on so that it glides along the outer wall of the chamber, towards which the cutting edge is turned. When the knife has entered for about 5 or 6 mm. he cuts the choroid from within outwards, down to the sclerotic, by small sawing movements, taking care not to enlarge the original opening. In this way all risk of prolapse of iris is avoided. Querenghi claims that the incision made in this operation forces a passage between the peri-choroidal spaces (in which he places the real origin of the disease) and the aqueous chamber. It is, perhaps, unnecessary to add that this theory has little or no support from other investigators.

Heine (25) has recently enunciated a somewhat different theory for the explanation of the action of iridectomy in glaucoma, and from this base has elaborated an operation for its relief. He calls to mind the observations of Fuchs on detachment of the choroid in eyes after iridectomy or cataract extraction, and the hypothesis of Axenfeld, that such detachment may have important bearing on the method of cure, and deduces thence the advisability of establishing a communication between the anterior chamber and the supra-choroidal space. This theory is very closely related to that of Querenghi, which we have just mentioned, but the means to gain success are not the same.

Heine's Operation

Instruments.—Speculum, fixation forceps, scissors, keratome and iris spatula.

First Stage.—The surgeon lays bare the sclerotic at some point, about 5 mm. from the limbus, by dissecting up the conjunctiva.

Second Stage.—He then makes, with the keratome, a small incision, some 2 mm. long, obliquely through the sclerotic about 5 mm. from the limbus, and, therefore, over the ciliary body. The incision goes through sclerotic only and does not interest the ciliary muscle.

Third Stage.—Then taking the spatula, the surgeon introduces it through the wound, keeping its end close to the sclerotic, and presses it onwards through the ligamentum pectinatum until it appears in the anterior chamber. This makes a communication between the two spaces named. By lateral movements the ciliary body and the root of the iris are separated from the sclerotic as far as is thought desirable: the separation involves division of the ligamentum pectinatum to a corresponding extent.

Fourth Stage.—The withdrawal of the spatula is not without great importance, since the surgeon has it in his power, according to Heine, to decide by the mode of retiring whether the intra-ocular pressure falls at once, or whether the fall is gradual and spread over many hours. There is no necessity for the escape of any aqueous humour if the withdrawal is gradual; in

this case the fall of pressure will not be apparent at once, but will take place after an interval. If, on the other hand, the surgeon desires a rapid and immediate fall, he can, by a slight rotation of the spatula, open the door to the free flow, and the tension will fall with corresponding rapidity.

The manipulation is not a difficult one, and might fairly be tried where other means have failed, but the enunciation of the theory and method is too recent to allow any expression of opinion as to its real merits.

That good results have followed all these procedures from

FIG. 110.—Heine's operation ; diagram.

time to time seems clear from the reports; it is impossible to question the accuracy of the observations any more than the good faith of the observer, but we may be allowed to hold different views on the subject of the explanation.

The action of these procedures can hardly depend on the very small scleral or corneal wound, and the natural question arises, Has the division of the ciliary body and the base of the iris, and also in all probability of the suspensory ligament of the lens, any part in the reduction of pressure? If we accept the view that the primary rise depends, in some way, on the obstruction of the passage of the fluid from the vitreous to the posterior

aqueous chamber, it is clear that an incision through the structures named will tend to reduce the pressure by providing a more easy path for the fluid to travel. It is possible even that the division of the ciliary muscle may, by breaking the continuity of the circular fibres, lessen the prominence of the ciliary processes, and thus increase the size of the circumlental space. These questions must remain unanswered, except theoretically, since there are no records, to our knowledge, of any anatomical examinations.

It seems to us most probable that the relief noted is the result of a communication established between the vitreous and the aqueous chamber; this hypothesis has been suggested by no less an authority than Sir William Bowman (26), who advocated, in certain cases of glaucoma, an incision with a broad needle through the tissues from the cornea backwards to the vitreous.

Teale (27), in his Bowman Lecture, delivered to the Ophthalmological Society in 1892, adheres to the same opinion. And more recently, at the Ninth Ophthalmological Congress, at Utrecht, in 1899, Hern (4) read a short communication on this point.

When iridectomy has not relieved the tension, he suggests the following procedure, which he attributes to Bowman and Teale.

Hern's Operation

Instruments.—A narrow knife, about 1 mm. broad, and sharp on both edges, is the only absolute necessary; a speculum and fixation forceps will often be a convenience to the operator.

The knife is passed through the cornea about 2 mm. within the transparent tissue, through the coloboma of the iris, and above the margin of the lens, through the suspensory ligament into the vitreous (or through the iris if the high tension have appeared after a simple extraction, as in Bowman's cases).

During this passage the knife is held so that the plane of the blade is parallel to the horizontal plane of the eyeball. By

lateral movements the zonule is opened to the largest possible extent.

The effect of this little incision is to open a free passage from the vitreous chamber to the aqueous, and, on the supposition that the primary rise of tension is due to the want of normal filtration between these cavities, the method of relief is clear.

It would seem that there must be a little danger of dislocation of the lens if the zonule be divided largely; there is no evidence, as far as we are aware, that this danger is a grave one, or that the accident has ever been observed.

Posterior Sclerotomy

This little operation was among the first adopted for the relief of high tension, and though it has no claims to be considered a curative measure, yet may be of great assistance to the surgeon.

Motais (28) has recently written in favour of this little operation, and has pointed out that the position of the scleral puncture is of more importance than is usually supposed. Unless the capsule of Tenon be opened during the passage of the knife, the mass that escapes from the eye is small. The incision, therefore, must lie behind the insertions of the recti. On the other hand, there are several good reasons for keeping it close to the insertions. If it lie far back it may divide the tendon of one of the oblique muscles, or may open one of the large vorticose veins which emerge from the sclerotic about 1 mm. or 2 mm. behind the equator. The network of the choroidal veins is necessarily cut at any place, but the network is less close near the ora serrata, and here also the retinal elements are less developed.

For all these reasons the wound should be in front of the equator; and Motais advises that the incision should have a length of 3 mm., rather more than less, and should be "*en morsure de sangsue.*"

The exact position relative to the muscle will vary in the different sectors of the eye; the diagram from Motais will show the relative distances from the cornea.

The operation is simple.

In acute glaucoma the eye is so tense that a general anæsthetic is necessary; but the performance is momentary, and gas gives anæsthesia of sufficient length.

Instruments.—Speculum, fixation forceps, von Graefe's knife.

The speculum is inserted, and the surgeon grasps a fold of conjunctiva, near the outer margin of the superior rectus, and rotates the globe downwards. The conjunctiva slides over the subjacent tissues, and thus, when the incision is made, the openings in the conjunctiva and sclerotic do not agree, and the scleral wound is effectually protected as soon as the conjunctiva is allowed to take its normal place. The surgeon punctures the tunics of the globe with the knife, holding it in a meridional plane, with the edge and point somewhat backwards so as to avoid the lens; the spot selected for the puncture should be rather in front of the equator, well away from the venæ vorticosæ, midway between the superior and external recti.

The knife is thrust about 5 mm. into the eye and is then withdrawn. The scleral wound is covered by conjunctiva, which is pressed up by the outflow of some of the intra-ocular fluid. If the surgeon desire to make the wound leak for some days, he may with advantage rotate the knife round on its axis before withdrawal; this makes an incision like a leech-bite (*morsure de sangsue*), L- or T-shaped.

Tobler (29), of Bale, has shown experimentally that the risk of hæmorrhage is much greater if the incision be made in the equatorial plane instead of in a meridional plane, because the choroidal veins are cut across in the former.

The tension after one of these procedures falls rapidly to normal, the anterior chamber regains its depth, and the iris recovers its power, so that eserin brings about contraction.

It is theoretically possible that there should be troublesome bleeding after the puncture, but it has never been recorded.

Such a puncture will keep the tension down for two or three days.

Priestley Smith makes such an incision as a routine procedure

immediately before performing an iridectomy for acute glaucoma, and many other surgeons have adopted the same plan. The increased depth of the anterior chamber is one great advantage to the surgeon, another is the more gradual fall in pressure which follows the puncture as compared with the scleral incision for iridectomy. There is less risk of expulsive hæmorrhage if a preliminary posterior sclerotomy has preceded the major operation. Lastly, if for any reason iridectomy be deemed inadvisable, whether from septic conditions of the eye or from the immediate risk of an anæsthetic, the puncture allows us time to prepare the patient, and, if necessary, with the lowered tension, cocain anæsthesia can probably be used for the major operation at a later date.

Motais, in the article from which we have already quoted, states that he habitually follows the operation by systematic massage, beginning on the day after the puncture; the massage is repeated every two hours for five minutes during at least a fortnight; he thinks that by this means we can, without harm to the patient, retard the cicatrisation of the wound and preserve its filtration. If it appears advisable, he repeats the puncture, taking care to avoid the former wound.

Operations on the Sympathetic Nerves

Abadie (30), in 1897, brought forward a theory of glaucoma, according to which the hypertension depended on a vascular disturbance; to remedy this he proposed to deal with the vasomotor nerves of the eye as they lie in the cervical sympathetic.

This was not the first time that the action of the sympathetic nerve on the tension of the eye had been observed; as far back as the twelfth volume of von Graefe's *Archives* may be found the observations of Wegner (31), who noticed changes of the intra-ocular pressure in animals when the cut end of the cervical sympathetic was stimulated.

Nor was Abadie the first to apply the suggested measures, for his paper was very shortly followed by one from Jonnesco (32), describing the results which he had obtained by carrying

out the suggestions of Abadie. There can be no doubt, however, that the credit of the suggestion is due to Abadie, though in some sense he was forstalled both in idea and performance.

The upholders of the method are not in unison in the matter of explanation. According to Abadie, the direct cause of glaucoma is an active dilatation of the blood-vessels, particularly the arteries. This gives rise to an increase of exudation, and hence an increase of pressure. The dilatation he ascribes to the activity of the vasomotor centres. When the chain is cut the stimuli cease, and the blood-vessels resume their normal calibre. It is true that the healthy sympathetic, when stimulated, causes contraction of the arteries, but in glaucoma we must be dealing with a diseased nervous system; this accounts for the change.

Jonnesco, on the other hand, declares that the small arteries are contracted, that the resulting increase of intravascular pressure brings on an increased transudation, and probably an increase in the amount of aqueous humour.

It will be seen that these two theories are in direct opposition as to the conditions of the vessels. But since this point is regarded by both parties as a crucial one, it cannot be said that theory gives much support to the method.

As to its efficacy, there is room for considerable doubt: it cannot be denied that, at least in many instances, division of the chain or avulsion of the superior ganglion is followed by contraction of the pupil and decrease of the intra-ocular pressure; but this improvement is, in almost every case, temporary only, and the pressure rises again after a long or short interval.

It is possible now, after the lapse of some years, to look back over the reports of cases and judge fairly as to the value of the line of treatment; this has been done by many surgeons, and we can now speak with some certainty. Jarland, Lagrange, Loring, and Axenfeld have all written on this point comparatively recently, and they express a remarkable agreement. They find that the removal of the superior cervical ganglion has little

effect on any form of glaucoma except the very chronic. Here it is almost always followed by some improvement—the pupil becomes smaller and the tension falls. In a few weeks, however, the tension again rises, and after a variable interval the disease takes its former course.

They agree that the operation should never be undertaken as a primary measure, but, when iridectomy and miotics have failed, it offers the prospect of a retardation, and perhaps a temporary improvement of vision, at a small risk. Within these limits the operation may fairly be considered in cases of very chronic glaucoma (glaucoma simplex).

The superior cervical ganglion, that part of the sympathetic chain which chiefly concerns us now, probably represents the fused ganglia of the four upper cervical segments. It lies very deeply in the neck, encased in layers of cervical fascia, upon the longus colli muscle, at the attachment of this to the anterior tubercles of the transverse processes of the second and third cervical vertebræ; in front and a little to the outer side is the internal jugular vein, and on the inner side of this the vagus nerve, both of these structures being contained in the carotid sheath. The ganglion is connected with the cervical spinal nerves by means of several connecting branches; above, it sends off the plexiform masses, called the carotid and jugular plexuses; below, it is connected with the middle cervical ganglion by the cord of the sympathetic.

There are two chief routes which may be taken to reach the ganglion—the road by the front of, and that by the back of, the sterno-cleido-mastoid muscle. The former was that chosen by Jonnesco, and still generally adopted, but with one great difference from the original plan. Jonnesco, having laid bare the carotid sheath, deliberately opened it and passed between the artery and the vein. This is a needless risk; Burghard points out that it is easy to pull the whole sheath inwards and find the sympathetic ganglion behind. The other route, by the back of the sterno-mastoid, has the great disadvantage that it exposes the spinal accessory nerve to the risk of division. If,

then, the operation be undertaken, we shall do well to choose the "anterior" route.

The results of the operation are by no means constant; certain features, it is true, appear in every case, but they are not those which the surgeon chiefly desires.

The constant symptoms are ptosis, narrowing of the pupil, even in those cases where an iridectomy had been performed before, congestion of the face, and headache. It will be noticed that none of these, with the possible exception of the miosis, is of any value in the cure of the disease. The inconstant symptoms are diminution of the intra-ocular tension and alteration of the prominence of the globe. Very severe neuralgia, spreading down the arm on the side of the wound, is not uncommon; it sometimes radiates over the same side of the head. When it occurs it can seldom be relieved without the use of morphia.

Operation by the Anterior Route

Burghard (33), gives the following directions for this operation:—

First Stage.—The surgeon makes an incision along the anterior border of the sterno-mastoid, about three inches long, having its centre opposite the angle of the jaw. He divides the various layers of the cervical fascia, and lays bare the border of the muscle, which is pulled outwards.

Second Stage.—This displacement exposes the sheath of the large vessels, and the surgeon defines the outer edge of the sheath and pulls it inwards towards the middle line, exposing in turn the superior cervical ganglion.

Third Stage.—The surgeon then picks up the ganglion in forceps, frees it by slight dissection, and divides with curved scissors the ascending branches close above the top, and the descending cord about half an inch below the ganglion.

Fourth Stage.—The wound may then be closed by sutures.

Though himself advising an attack of the great sympathetic

trunk, Abadie mentions that at some future time it may be possible to deal with the local sympathetic twigs in the ciliary ganglion.

Rohmer, of Nancy (34), in 1902, gave an account of some cases in which he had removed this structure, and gives directions for its removal. The little ciliary ganglion, a nerve mass not more than 2 mm. in its largest diameter, lies deeply buried in the orbit surrounded on all sides by orbital fat, and having relations more or less close to important structures. It is situated about 15 mm. behind the posterior pole of the eye, and about 9 mm. in front of the optic foramen, lying between the external rectus muscle and the optic nerve, but in a plane a little below the latter. One of the long posterior ciliary arteries intervenes between it and the nerve. The removal from this position clearly calls for considerable surgical and anatomical knowledge.

Removal of the Ciliary Ganglion

Rohmer's Operation

It can be seen from the anatomical description, given above, that the surgeon has to work in a small space, and Rohmer has devised special forceps to enable him to tear away the ganglion in its bed of fat. These are a modification of the common forcipressure forceps: one blade is grooved on its outer surface longitudinally, so as to be guided along the optic nerve on its outer side.

The extremity terminates in an enlarged plate which is sharp enough to cut the soft fat. The inner surface of this plate is smooth, the opposing surface of the other blade is cut in crossed grooves, which can therefore firmly hold the tissues grasped.

Instruments.—Besides the forceps just described, there are needed for the operation the instruments for Krönlein's resection of the outer orbital wall, which forms the first stage of the operation.

First Stage.—Krönlein's operation must be performed in the usual way.

Second Stage.—After dislocating the bony flap outwards, the surgeon incises the periosteum and orbital fascia, for about half an inch, and through this opening searches for the external rectus.

Third Stage.—The muscle is brought out of the wound, a silk suture is passed through it, so as to retain it against slipping back into the orbit beyond reach, and the muscle is then divided at a little distance from its insertion. The point of division is chosen so that reattachment may be easy at the end of the operation.

Fourth Stage.—The special forceps are then passed backwards half open into the depths of the orbit, the inner blade being guided along the optic nerve until the surgeon knows that he has reached the vicinity of the ganglion. Then the blades are closed and the forceps withdrawn, holding and dragging out a mass of the orbital fat, which yields easily. If the surgeon encounters any resistance, he has probably hold of a muscle and then must reopen the forceps and take fresh hold. The fragments of fat avulsed are spread out on some convenient surface to allow their examination. Rohmer makes from five to seven bites with the forceps.

Sometimes he has been able to recognise the ganglion, sometimes it has been overlooked, crushed out of all recognition by the forceps.

There is usually free hæmorrhage during this stage. As soon as the ganglion is removed, it will be noticed that the conjunctiva becomes paler and the tension falls. The surgeon then proceeds to the closure of the wound.

Fifth Stage.—The external rectus is reunited, the bony flap put back into place, and the skin wound stitched up. It is well to place a small drain into the orbit.

Rohmer has removed the ganglion without the preliminary resection of the malar bone, but thinks the freedom which this resection gives more than counterbalances the increase of severity of the operation. The results obtained in Rohmer's

cases were recorded as good, but we are not aware that any other surgeon has imitated him.

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CHAPTER X

SOME OPERATIONS ON THE CORNEA, SCLEROTIC, AND IRIS

The Treatment of Corneal Nebulæ and Leucomata

When the superficial layers of the cornea are occupied by a scar, as, for instance, from extensive ulceration, while the remaining structures of the eye are normal, it seems lamentable that the loss of transparency of the cornea should totally prevent the use of the eye, whose essential parts remain otherwise intact.

There have been, therefore, many attempts of different forms to find a way of restoring the function of the eye.

The principles of the procedures vary according to the condition of the eye. Where the scar is comparatively small, and some clear cornea remains in the pupillary area alongside of the nebula, the visual defect depends on two factors—the semi-opaque scar tissue permits the passage of a considerable amount of diffused light, which, reaching the retina, blurs the image formed by the unaltered adjacent parts, and, further, the contraction of the scar gives rise to astigmatism, regular or irregular.

The first may sometimes be corrected by tattooing the scar with Indian ink, thus blocking out the imperfections of the refracting surface. Before undertaking the operation it is well to experiment by covering the semi-opaque regions, the cornea being under the influence of cocain, with fragments of black paper. Unless improvement is noticed, it is useless to put the patient to the inconvenience of an operation, since there is no probability that tattooing will have more success.

When the central part of the cornea is occupied by a dense opacity, so large that tattooing alone has no chance of success, it may yet be possible to improve vision and restore the utility of the eye by displacing or enlarging the normal pupil or putting a new second pupil behind a clear part of the cornea. Such an operation may often be combined advantageously with tattooing of the scar.

Displacement of the normal pupil has been attempted; the operation of iridesis, devised by the elder Critchett (1), consisted in pulling the pupil over to one side and fixing it by establishing an anterior synechia. The second object, enlarging the pupil, can be attained either by the application of a drug or the excision of some part of the iris.

Critchett's operation has been given up, in spite of the success which he records and which Bowman also acclaimed, because in the practice of other surgeons the anterior synechia has proved to be an element of grave risk to the patient. Permanent use of mydriatics, also, is frequently attended with serious danger; the surgeon must, therefore, often remove some part of the iris in the attempt and aim of improving vision.

Such an iridectomy is often called optical: as we have already indicated, it may act in one of two ways, either by enlarging the pupil or by making a second pupil behind the clear cornea.

The choice of position for the new pupil is usually important when we are dealing with a corneal opacity. In considering previous iridectomy operations it was pointed out that in glaucoma the attached margin of the iris was that which we were chiefly concerned with, while in preliminary iridectomy the peripheral, pupillary margin was that to which our attention was directed, since this margin was specially likely to prolapse. In optical iridectomy we desire to place the new pupil so that it may be situated as favourably as possible with regard to the refractive media. To secure this, the surgeon, if he is about to perform an optical iridectomy for a leucoma, must closely examine all the cornea, both before and after mydriasis, to discover what part of the cornea is clearest and least deformed.

He will often find, to his disappointment, that a portion of the cornea which seems clear before mydriasis is really hazy, since a leucoma, although often apparently sharply defined, usually is surrounded by slight nebulosity. And this haze is not by any means the most important factor to be considered; the contraction of the scar usually has left very irregular astigmatism, which deforms the image and decreases the visual acuity even though the cornea appear clear.

The fundus oculi must be examined carefully with the ophthalmoscope, and the part of the cornea noted through which the details are seen with the least deformity.

That this irregular astigmatism is of more effect than the haziness of the cornea can be readily seen if the student tests the visual acuity of patients with corneal nebulæ from old ulceration, and compares it with that of others afflicted with apparently equal amount of opacity from interstitial keratitis; he will often be surprised how well the latter see and how defective is the vision of the former.

The choice of position for the new pupil is limited; the opening must not extend outwards beyond the intermediate zone of the iris; if the part beyond this is removed, the circumlental space is exposed. Refraction will be so irregular that the vision regained will be very imperfect, and diplopia is not unlikely. Even if the excision be rather less peripheral, over the extreme lateral region of the lens, this is usually very unevenly curved, and so but a poor refractive apparatus. Nor should the sphincter iridis be cut if it can be avoided; the resulting coloboma will necessarily gape if the iris be healthy, and it is, speaking generally, advisable to keep an optical iridectomy as small as possible. Other things being equal, the excision should be made as near the normal pupil as possible, since the curvature of the lens is most regular here.

It is often stated that the size of the piece removed depends on the position of the inner mouth of the corneal wound; the smaller an iridectomy desired, the further within the clear cornea should the surgeon place his incision. This is only true

if the surgeon makes a point of removing as much iris tissue as possible in every case. It is certainly bad teaching. For what are the consequences? We are taught that if we should wish to make a small iridectomy, we must place the corneal incision within the corneal limbus. Now if the area of clear cornea be limited, the wound, which will itself be somewhat opaque, will still further reduce it, and may probably give rise to irregular astigmatism in the neighbourhood. Both these occurrences will diminish the value of the new pupil. The clear cornea in the region behind which the coloboma is to be made must be respected with the utmost care. Any incision must be as far as possible from it, and should, that is to say, lie in the sclero-corneal junction, and this is the more important the more the field for operation is limited.

The method of election, then, must be capable of varying the position and amount of the iris excised to suit each individual case. The procedure usually adopted is as follows:—

Optical Iridectomy

Instruments.—Speculum, keratome, fixation forceps, iris forceps, scissors and repositor.

First Stage.—The Corneal Incision.—The surgeon, having examined the cornea and selected the seat of the operation, stands on the corresponding side of the patient—*i.e.* if the incision is to be on the inner side of the right eye, or on the outer side of the left, he will stand on the left side. The lateral position is, we think, most convenient, but many surgeons stand behind, as for extraction of cataract. Seizing the conjunctiva in the fixation forceps close to the selected area, he makes with the keratome an incision about 6 mm. or 8 mm. long at the corneal margin, just external to that part which he found most transparent, behind which, therefore, he desires to place the artificial pupil.

Second Stage.—The Iridectomy.—Then taking the iris forceps in his left hand, he introduces them closed through the wound

until the points are opposite the part to be excised. They are then allowed to open slightly; the fold of iris is grasped and

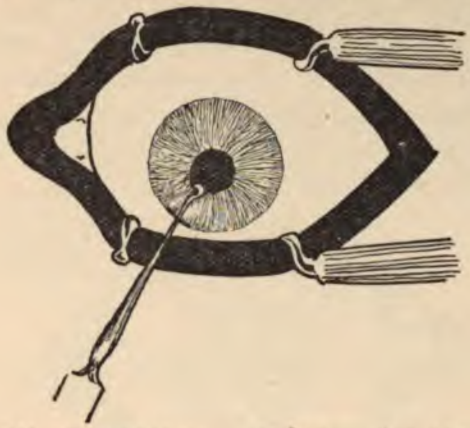

FIG. 111.—Optical iridectomy. The iris caught in iris hook.

drawn just out of the wound. The scissors are taken in the right hand, with the blades lying radially across the part to be

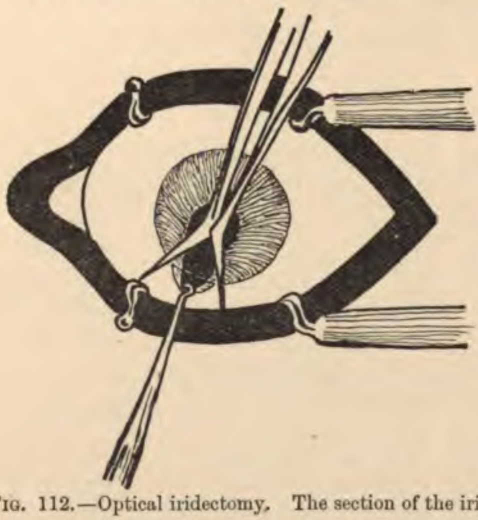

FIG. 112.—Optical iridectomy. The section of the iris.

excised, and by a single closure cut off the selected part; by making the scissor-cut radial the part excised is kept smaller than if the cut were transverse. The blades should press a

little on the cornea at the moment of section. The remainder of the iris flies back free from the wound into the anterior chamber, and the new pupil is made.

This operation is not in all points entirely satisfactory. If the pupil margin is adherent to the lens, it is sometimes difficult to draw the part of the iris desired out of the eye, and it is always a little difficult to regulate the size of the iridectomy.

Some surgeons prefer to draw the pupillary margin of the iris

FIG. 113.—Optical iridectomy completed.

out of the eye with a Tyrrell's hook, and either excise a small part or merely incise it radially, as seems best in each case.

BRUDENELL CARTER'S (2) METHOD OF OPTICAL IRIDECTOMY

This method is comparatively little known, but in several respects is better than the other. It is easier to place, by this method, the iridectomy at the spot selected, and to regulate the size of the piece excised.

Instruments.—The same instruments as for the preceding operation, but a pair of de Wecker's spring scissors are wanted instead of the usual pair, and iris forceps are rarely required, though it is convenient to have them in readiness.

First Stage.—The position of the corneal incision is chosen and the incision made in the manner just described.

Second Stage.—The surgeon then takes the spring scissors, and passes them closed into the anterior chamber, so that the points extend just beyond the piece which he wishes to excise. Now he allows the blades to open slightly, and a tiny fold of

iris springs up between them. The size of this fold may be regulated easily by the amount of opening of the blades. On closure of the scissors this fold is cut off, and a small opening is left in the iris. The size of the fold regulates the size of the opening. When the scissors are withdrawn, the fragment

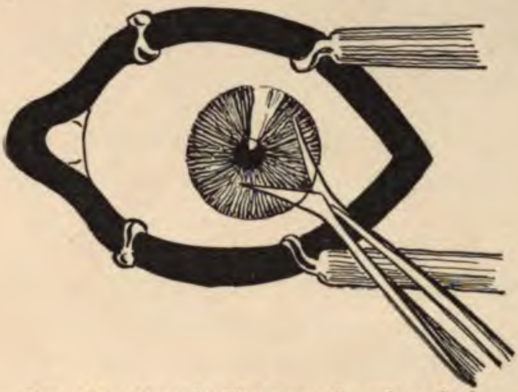

FIG. 114.—Optical iridectomy. Carter's method.

of iris almost always comes out with them; if it does not, it may be seized with the iris forceps and drawn out after.

Not very infrequently, especially when the iris is adherent by its pupillary margin to the lens, the fragment is not

FIG. 115.—Optical iridectomy. The pupil made by Carter's method.

completely separated. It is seldom, however, necessary to make a second incision to remove it. The contraction of the iris will enlarge the opening sufficiently to allow useful vision, and the new pupil, though not circular, will serve every purpose.

In this little operation the points of the scissors should not

pass beyond the pupillary margin of the iris. If they enter into the pupil, they may come in contact with, and wound, the lens capsule, giving rise to a traumatic cataract. If the sphincter be left untouched, not only this risk will be avoided, but also the new pupil will be more useful for the purpose for which it is required.

The risk of traumatic cataract has been largely exaggerated in connection with this procedure.

If the central opacity of the cornea exist with absence of the lens, an iridotomy, either with knife or scissors, is probably the best treatment.

Sometimes the surgeon has to deal with eyes from which the lens has escaped and the iris has become adherent to the cornea over all its surface. The anterior chamber may be entirely absent; an iridectomy cannot then be performed according to the usual methods, and even the operation of Gayet and Dufour (*vide* p. 298) is inapplicable. It may, however, still be possible to incise the cornea and iris at the same time, and remove the iris from behind. Such an operation has been performed by Deschamps (3).

Deschamps' Method of Iridectomy in the Absence of any Anterior Chamber

Instruments.—Speculum, fixation forceps, linear knife, iris forceps and scissors.

First Stage.—Having selected the spot at which he wishes to perform the iridectomy (or place the artificial pupil), the surgeon thrusts the knife through the limbus corneæ, and subjacent iris, at a point some 4 mm. at one side of this; he carries the knife on for a distance of 4 or 5 mm. behind the iris, and makes the point re-emerge through the iris and cornea in the limbus at a point symmetrical with the point of entry. When the puncture and counter-puncture have been placed, the surgeon cuts through the intervening tissues. The hyaloid

membrane is necessarily divided, and the vitreous protrudes into the superficial wound.

Second Stage.—The surgeon then passes the iris forceps through the wound in the cornea and iris into the vitreous chamber, and then, directing their points forwards, tries to seize the iris from behind. After scratching and tearing the tissues with the points of the forceps, he may be able to grasp a fragment and separate it from the cornea so far that it may be cut off with the scissors.

Even if he be not able to remove any sizable piece, owing to the close adhesion between the cornea and iris, he may yet be able to scrape a clear hole piecemeal by the points of the forceps, through which vision may be possible.

Peritomy and Peridectomy

When the cornea is the seat of a vascular opacity, as may be found after extensive corneal ulceration, or trachoma, the surgeon may often bring about great improvement in the condition by securing the obliteration of the vessels. This can be done most readily by the operation of peritomy.

This term is often used to include both the procedures named above; the aim of both is the same—to cut off the new vessels from the cornea—and their success is greatest when the vessels are superficial.

Instruments.—Speculum, fixation forceps and strabismus scissors; sometimes a small squint hook is useful.

In peritomy proper the surgeon picks up a fold of conjunctiva at some point near the cornea, and cuts through it with the scissors, as close to the sclero-corneal junction as possible. He extends the incision all round the circumference of the cornea, if necessary. If there are only a few separate vessels, confined to a limited zone, he will adapt the length of his incision to the needs of the case. He then picks up the bulbar conjunctiva in the forceps, and dissects it back for about a quarter of an inch.

The vessels are divided, and the cicatrisation of the healing

tissues causes a contraction sufficient to strangle any new vessels which may be formed afterwards.

In peridectomy, the effect is increased by cutting away the part of the conjunctiva which has been dissected back; the scar tissue is more abundant, and the bar against new vessels more secure.

Deeper vessels may be obliterated by the galvano-cautery.

Keratoplasty

When the whole cornea is so opaque that no optical iridectomy is feasible, von Hippel (4) and others have proposed to manufacture a new cornea. Von Hippel and his followers have had some slight success by transplantation of the cornea of some lower animal; Dimmer (5) and others have attacked the problem in another way—by substituting an entirely artificial cornea, made of celluloid in most instances, for the diseased tissue.

Von Hippel's Operation

Instruments.—Speculum, fixation forceps, special trephine, knife and dissecting forceps.

First Stage.—The surgeon takes the special trephine, whose crown is about 4 mm. in diameter, and holding it vertically, at right angles with the surface of the cornea, incises the tissues down to Descemet's membrane. This stage presents considerable difficulty in performance, and requires great care; if the trephine be not accurately held, the walls of the wound will not be vertical, and the implanted flap will not adhere and heal in. If the depth be insufficient, some of the scar tissue may be left, and the operation cannot be successful. There is often free bleeding from the vessels which run to the scar. This may be controlled by cold compresses or adrenalin.

Second Stage.—Now with knife and forceps he removes the scar tissue from the area within the circular incision, and leaves Descemet's membrane exposed.

Third Stage.—With the same trephine he then excises a

circular piece of the cornea of a rabbit; the incision must go through the whole thickness, and the graft, therefore, consists of all the tissues of the cornea. This graft is placed on the bed prepared for it.

The conjunctiva is washed out with weak antiseptic lotion, the graft is sprinkled with iodoform, and the lids are closed. Both eyes are bandaged for some days.

Von Hippel claims to have done much good by this procedure, but it has never been adopted very generally.

Dimmer, as we have said, implanted artificial corneæ of celluloid; these were held in place by means of a flange which was left round the artificial cornea. Connective tissue grew over and beneath the foreign body, embedding it. The account given by Dimmer, in the *Heidelberg Reports for 1886*, is chiefly interesting as showing how much an eye will undergo under certain conditions without immediate destruction.

These operations have been almost entirely abandoned, largely on the theoretical grounds that no permanent good could follow, and not on account of their inherent risk or difficulty.

Salzer (6), who made wide experimental researches on the subject, came to the following conclusions: that a total keratoplasty cannot succeed in any case, but that a partial keratoplasty may fairly be expected to give favourable results if it be performed on an eye having a superficial, little vascular, and stationary opacity.

When, he says, a piece of tissue from the same individual or from another of the same species is implanted on to a new situation, it retains for a considerable time its own proper structure; after an interval of greater or less length it is gradually absorbed and replaced by intruding elements of the adjacent tissues in which it is embedded. Finally there is found in the situation of the graft a mass very similar to, but not absolutely identical with, the surrounding regions.

Fuchs (7) gives an account of the microscopical examination

of an inserted graft, and shows that it by no means necessarily becomes altered throughout its whole extent, but that it may preserve its normal structure in great part, and concludes that Salzer's decision is too sweeping.

Gradenigo and van Millingen have tried to solve the problem by attaching to the eye an artificial cornea of glass. The former uses a mass shaped like a mushroom, the stalk being inserted into the anterior chamber and the head being thus held in position.

Van Millingen (8), in the reports of the Ninth International Congress of Medicine, held at Rome, 1894, gives an account of a method, which he has adopted in such cases with most surprising results.

He removes the whole thickness of the cornea by means of a trephine about 3 mm. in diameter, and through this opening extracts the remains of the lens, which is almost always degenerated; as soon as the pupil seems clear, or the vitreous presents in the wound, he applies to the surface of the eye a transparent contact glass, shaped like an artificial eye; the air is removed from under this and replaced by some saline fluid (normal saline) by means of a syringe. A patient, quoted by van Millingen in this communication, had by this means obtained and kept vision of 6/24 for a period of eighteen months.

Baker (9), in the *American Journal of Ophthalmology* for 1889, has given an account of a case where he made use of a glass button shaped like a shirt stud, with which useful vision was retained for some months before the eye softened and was lost.

The Operative Treatment of Abnormalities in Curvature of the Cornea

It is well known that after extensive corneal incisions there follows in most instances fairly regular flattening of the cornea in the diameter opposite the centre of the incision. Thus after cataract extraction the refraction almost always shows some

astigmatism, with the axis "against the rule," the vertical diameter being less refracting than the transverse. Such astigmatism is usually regular, but varies considerably during the first months after the operation. It is, however, usually permanent in part if not entirely. This knowledge has led some surgeons to attempt to remedy physiological, congenital astigmatism and other refractive errors by producing, on the corneal margin, scars, which by contraction should change the curvature of the cornea in the desired direction and to the desired extent.

Thus Maddox (10) has recounted how he removed 3·0 D of myopia which prevented the patient entering the army. Brewer (11) has also recorded some success in removing astigmatism, but most surgeons do not deal with such slight deformities by operation.

Conical Cornea

The treatment of conical cornea dates back to the middle of the last century, when the condition awakened the attention of Bowman (12).

In the second volume of the *Royal London Ophthalmic Hospital Reports* he writes on this subject, and describes an operation for its relief. He had found that nothing gave these sufferers such good vision as a stenopaic slit, and he thought that if the slit could be placed within the eye the resulting vision would be better than ever. He therefore adopted the procedure of Critchett, called iridesis, to his end.

The operation of iridesis was devised to allow the surgeon to fix the iris at any given point; a small incision was made with a broad needle through the corneo-scleral junction at the point selected and a noose of thread laid on the cornea surrounding the opening; forceps were passed through the loop and through the wound, seizing the iris midway between the ciliary and pupillary margin; the part seized was drawn out of the eye and secured by tying the loop.

Bowman modified the operation slightly in that he drew the pupillary margin out by a fine hook, but with this slight

alteration he performed the operation of iridesis twice on each eye, converting the pupil into a narrow transverse slit, with considerable improvement of vision. Unfortunately the operation was not unattended by risk: in some cases severe iritis and even sympathetic inflammation followed. The method, therefore, found few imitators.

A few years later, von Graefe (13) described the good results which he had obtained by cauterising the apex of the cone; the resulting scar flattened out the deformed cornea and improved the curvature of the refractive surface. Von Graefe used to remove the epithelial coat by scarification, and then to apply to the raw surface a fragment of silver nitrate. This method was improved when Andrew (14) replaced the caustic by the cautery, and in this form it is still very often used.

Bader, at an early date, began to treat those patients who suffered from this complaint by excising an elliptical piece from the most prominent part of the cone, which is also the thinnest part: when the lips of the wound fell together, the cornea was reformed with almost normal curvature. Higgens and Morton in England, and Badal and others in France, have adopted this operation largely, but the large number of cases in which extensive anterior synechia has followed, with great inflammation, and perhaps total loss of the eye, has acted as a deterrent to many surgeons, who have chosen the safer but less brilliant method of cauterisation.

The results obtained by the excision of the cone are extraordinarily good in the best instances; Morton has from time to time shown patients on whom this operation has been performed, whose corneæ were absolutely transparent and normally curved, the linear scar being invisible except to the closest examination. The unaided acuity in such cases sometimes reaches normal. Yet even so brilliant an operator has some failures, and when the operation fails it often means total loss.

The evolution of the other chief method of treatment, that by the formation of a contracting scar over the region of the cone, has been slow. We have said already that von Graefe

recommended, in 1866, the formation of an ulcer on the surface of the cone and the application of a piece of caustic to the raw sore; he removed the superficial layers by a cataract knife. Bowman, to make the wound more regular, devised a special trephine, which cut a circular furrow to any required depth in the cornea, and suggested that the tissues within such a furrow should be dissected away. Neither of these methods were able to excite a sufficient degree of contraction in severe cases, and they were falling into disrepute when Andrew suggested the use of the actual cautery to cause the desired ulcer. In his first cases he purposely perforated the cornea, hoping in this way to prevent the intra-ocular tension from causing a second protrusion until the scar tissue had gained a certain strength.

Richard Williams (15), of Liverpool, a few years after, came to the conclusion that the perforation was not only unnecessary but even disadvantageous, and recommended that the surgeon should always stop short of opening the anterior chamber.

Critchett (16), in 1895, described a method by which he had obtained good results without perforation; it differed from Williams' method in that three zones were burnt to different depths, forming a design on the cornea which the author compared to a target, the bull's eye being destroyed to the greatest possible depth short of perforation. Combining this with optical iridectomy, in the necessary cases, very good results have been obtained.

Since the scar was large and almost central, optical iridectomy was comparatively commonly needed; and since the scar did not approach the margin anywhere, its vascularisation and healing were slow.

Work Dodd (17) proposed to burn a horseshoe round the apex, carrying the ends to the vascular limbus.

This method seems effective, and, inasmuch as the central zone of the cornea is untouched, the necessity for after-iridectomy is reduced. The scar, however, does not support the weakest area (the centre or apex of the cone), and it would seem more liable to an extension of the disease. Lately Elschnig

(18) has suggested making a large central burn, as in Critchett's method, and carrying the superficial area to the margin at the nearest point, so as to bring on vascularisation as speedily as possible.

Hirschberg (19) burns a ring of cornea so as to make a dense scar with a minute central opening; the scar is afterwards tattooed.

His idea is that by reducing the transparent area of the cornea he improves vision to the same extent as would a pinhole.

In mild cases attempts are often made to stop the progress of the disease, and even to cause its regression, by applying pressure to the surface. Kalt (20) says that he has found great benefit to his patients from blepharorrhaphy.

Other surgeons perform iridectomy. Badal has great belief in the power of this last. It is probable that its chief action is through the contraction of the corneal wound. Bossalino (21), of Turin, advocates section of the corneal margin, repeated, if necessary, after an interval.

Excision of the Apex of the Cone

Bader's Operation

Higgens (22) gives the following description of Bader's method:—

Instruments.—Speculum, linear knife, iris forceps, fixation forceps.

First Stage.—The surgeon transfixes the cone with the knife, passing the blade along the transverse meridian of the base of the cone and making the puncture and counter-puncture lie about 6 mm. apart. He then cuts outwards at some distance from the apex on the side of the cone. With an external wound of this size the opening into the anterior chamber is much less, probably not more than 3 mm., varying inversely with the thickness of the cornea, which is always more or less reduced in this disease.

Second Stage.—Now seizing the flap in fine forceps, he separates it entirely from the cornea by a second cut with the linear knife, this time cutting the tissues from without inwards. There is left, then, a lanceolate opening into the anterior chamber; if the skill of the operator has placed the incisions correctly, the edges of the gap fall together and fill in the whole space. There is always considerable risk that the iris will prolapse into the wound and prevent immediate union; it is almost impossible to guard against this risk. By having the pupil widely dilated before the operation, the chances are lessened, but in a certain number of cases prolapse will occur.

If too large a piece of corneal tissue have been removed, the gap cannot close at once, and prolapse and anterior synechia are certain.

BADAL'S (23) MODIFICATION

Badal describes a modification of this operation, which has some advantages over the original. The chief danger of the operation of Bader is the prolapse of the iris; no attempt being made to keep the wound closed, the iris is very apt to become entangled in the large opening and become fixed there, giving rise to severe inflammation.

Badal endeavours to secure speedy adaptation of the edges of the wound to prevent the reopening of the anterior chamber and oppose the prolapse of the iris.

Instruments.—Speculum, three fully curved needles armed with horsehair, linear knife, iris forceps, scissors and repositor.

First Stage.—The surgeon passes the three sutures in succession vertically across the base of the cone, in such a way that the points of entrance and exit of each suture are equidistant from the centre of the cone. The line of the points of entrance and that of the points of exit are almost parallel to the horizontal diameter, but the central suture encloses a little more of the cornea than the two lateral. The interval between the former should be about 7 mm., that between the lateral 6 mm.

It is important that horsehair be used for the sutures; no other material is so readily and certainly sterilised and kept

sterile. If silk be used, slight suppuration of the punctures is almost always seen, and is a redoubtable complication.

Second Stage.—Next the surgeon transfixes the base of the cone with the linear knife and removes an elliptical flap of the cornea, as in the original method.

Third Stage.—The sutures are then tied, bringing the edges of the gap into apposition.

Synechiotomy

The importance attached to the presence of anterior, and even more of posterior synechiæ has varied enormously during the past half century. Streatfield (24) regarded the presence of posterior synechiæ as an almost certain cause of recurrence of iritis, and therefore tried to break them down in every way—if needful, by operation.

His method was to make a small incision at some convenient spot, and insert a small hook with which he detached the adhesions in succession.

Passavant (25) recommends a slightly different procedure. He makes a puncture in the sclero-corneal junction, grasps the iris at the point of adhesion in iris forceps, and breaks down the adhesion by gentle traction. This method allowed of dealing with two adhesions at most from the same incision, and is thus inferior to Streatfield's. Ogston and Walker passed a cataract needle through the cornea into the iris near the adhesion, and levered the parts away from the lens.

There is no great difficulty in these operations, but experience has shown that the premiss of Streatfield is at fault, and therefore the chief reason for attacking posterior synechiæ is gone. If the surgeon has to perform an iridectomy in an eye where there are adhesions, he may as well free the pupil, if it be possible, but often the muscular tissue of the iris has undergone degeneration so that the pupil does not dilate, and the adhesions reform.

Anterior synechiæ are a more real danger, though even on this point there is much difference of opinion. Many surgeons

would divide, or at least attempt to divide, any anterior synechia, unless there were obvious contra-indications. On the other hand, many would not operate if the eye showed no signs of intolerance. Here, again, modern practice seems rather towards non-intervention.

Anterior synechiæ may be grouped for our special purpose in three divisions, needing separate treatment.

The first group are the thin, stretched bands which are easy to deal with. They may be divided without difficulty, by means of a narrow linear knife, passed through the cornea near them.

In the second group, a large extent, but not the whole width of the iris, is entangled in the corneal wound. Such a synechia is most easily dealt with by means of Lang's (26) "twin knives," of which the sharp "twin" is similar to Knapp's knife, and the blunt "twin" is exactly similar in size and shape, except that its point is rounded.

Bands of this kind de Wecker (27) advises us to attack with scissors. He makes an incision with the keratome, and introduces the scissors with one blade on each side of the synechia, and cuts through the iris. Clearly the aqueous must often escape, and hinder the operator.

Lang's Method of Division

Instruments.—The twin knives, speculum, and fixation forceps.

The surgeon seizes the globe with fixation forceps at the sclero-corneal junction, as near as possible to the adhesion.

He then chooses a point on the cornea, as far as possible from the synechia, from which the knife can pass between the cornea and iris beyond the synechia: at this point he makes a puncture with the sharp "twin." Then, changing the knife for the blunt "twin," and taking care not to lose the puncture, he introduces the second knife into the wound left empty by the withdrawal of the first, and guides it past the synechia, between the iris and cornea. When the point has reached well beyond the adhesion, it is easy to divide the iris tissue close to the cornea.

17

When the anterior synechia is very extensive, and a large part of the iris is entangled in a staphyloma of the cornea, Abadie (28) has proposed an operation which he calls staphylotomy. It was, in the first instance, devised rather to relieve the cornea from the incessant dragging of the iris, to which Abadie attributed the recurrence and intractability of the disease, but later he considers the matter from the side of the synechia. The following is his method:—

STAPHYLOTOMY

Instruments.—Speculum, fixation forceps and linear knife.

The method is suitable only when there is some clear cornea at the side of a large staphyloma, with extensive anterior synechia, and very shallow anterior chamber.

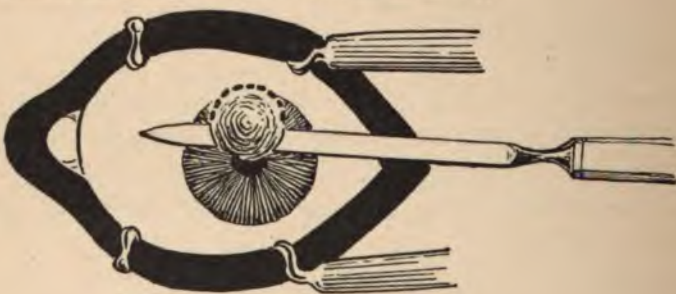

FIG. 116.—Staphylotomy.

The surgeon punctures the clear cornea just outside the margin of the ectasia with the linear knife, which he drives through cornea and iris. As soon as the point has passed the iris, he brings the handle of the knife into the plane of the corneal limbus, and presses onwards; in these cases the posterior chamber is unusually deep and there is little danger of wounding the lens; after a passage behind the iris of sufficient length to carry the point beyond the limits of the staphyloma into the region of clear cornea on the other side, he brings the point forward again through the iris and cornea.

Having thus made puncture and counter-puncture with the edge of the knife away from the clear area, he cuts out, dividing

the margin of the staphyloma, and necessarily also the whole or the greater part of the entangled iris fibres.

The result of this little operation is to free the ciliary margin of the iris from the incessant drag on the bulging cornea; the eye usually shows rapid improvement, the staphyloma flatten s and the scar heals with a comparatively normal curvature.

Detachment of the Retina

Detachment of the retina is still beyond the reach of efficient surgical interference, and we must rely, for the most part, on rest and therapeutical measures, either general or local. It is, however, not infrequently useful to tap the subretinal space and allow the free escape of the subretinal fluid. Lately Muller (29), basing his procedure on the theory that the detachment is due to the disproportion between the vitreous humour and the capsule of the eye which contains it, has proposed a somewhat drastic method of dealing with this accident and reports considerable success. Without an extensive trial, it would not be possible to pronounce definitely on the merits of his plan, but in view of the hopeless nature of the majority of these cases, it does not seem right to overlook any proposal which claims success. The idea of the operation is to lessen the supposed disproportion between the tunic of the eye and its content. Since it is impossible to attain asepsis of the conjunctiva, Muller seeks to operate on a part of the globe behind the equator, and therefore Krönlein's resection of the outer orbital wall forms the first stages of the new method. Then the surgeon begins the operation on the eye proper.

Muller's Operation

First Stage.—The external rectus is divided; the two parts are secured by sutures, so that they may be reunited at a later stage. This exposes, on the sclerotic, the tendon of the inferior oblique and the adjacent part of the muscle. It is not usually necessary to interfere with this.

Second Stage.—The surgeon with a sharp scalpel marks out a lanceolate area of the sclerotic, about 8 mm. in height and 4 mm. broad, and by careful incisions separates it from the rest of the sclera without wounding the choroid.

Third Stage.—A linear knife is passed through the choroid into the subretinal space in the region of the detachment, and the contained fluid drained away.

Fourth Stage.—The margins of the scleral wound are accurately adjusted and secured in contact by catgut; the external rectus is reunited, and the bony flap replaced.

Granting Muller's theories of the causation of detachment, the method seems reasonable. He claims that the results, in his hands, have been exceedingly good, but we are not aware that any other surgeon has followed in the same path. The fact that the ocular procedure is necessarily preceded by Krönlein's resection makes the whole a more formidable interference than most of those with which an ophthalmic surgeon is familiar; but if the operation were undertaken through the conjunctiva the risk of sepsis would be great, and in view of the uncertain result of the operation, it is doubtful whether it would be justifiable.

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